THROUGH THE LENS OF DEBITAGE: USE OF SPACE AT THE REINHARDT SITE

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Dedication

To my professors, mentors, and friends: Dr. Brian Bates, Dr. Jim Jordan, and Gary Gossett

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CHAPTER I: Introduction

Purpose of Research

Since the initial systematic investigation in the 1980s (Nolan 2010:37), archaeologists at the Reinhardt site (33PI880) have contributed to alleviating the paucity of prehistoric research pertaining to the middle and upper Scioto River Valley. Still, there remain limited academic studies which address use of space in this region. My research presented here expands upon the most recent excavations at Reinhardt conducted by Nolan (2010, 2011) by examining prehistoric use of space in the Middle Ohio River Valley (MORV) specifically the Scioto region, through the lens of lithic debitage.

The Reinhardt site is located in Pickaway County, Ohio (Figure 1). It is a Late Prehistoric period (A.D. 1000 – A.D. 1600) village nestled in the Scioto River Valley on the east bank of the Scioto River (Figure 2) (Nolan 2011:105-109) in Harrison Township (Figure 3). The village dates from approximately A.D. 1220 to A.D. 1400. Reinhardt's timeframe, location, artifacts, and assumed village layout (circular with a central plaza) indicate that the site primarily exhibits a Middle Fort Ancient component.

In addition to Reinhardt, there are a handful of late prehistoric sites which are well studied in the region. Especially significant to my research are the sites also attributed to the Fort Ancient archaeological culture, as they provide context for Reinhardt's village layout and artifact collections. These sites include, but are not limited to, Blain Village, the Baum, and Gartner sites in Ross County, Anderson Village in Warren County, the Locust site in Muskingum County, the SunWatch site in Montgomery County, and the O. C. Voss site in Franklin County. Researchers have extensively excavated all of these sites and, subsequently, have produced a majority of the literature pertaining to prehistoric life in the region. Some of the publications briefly examine how the sites' inhabitants viewed and used space but it is not a primary focus in any of the writings (Baby et al. 1964; Baby and Potter 1965; Barber 1978; Brady-Rawlins 2007; Cook 2008; Griffin 1966; Prufer and Shane 1970; Seeman 1985). Inspired by this gap in information, I chose to conduct research on the Reinhardt site to enhance the understanding of Late Prehistoric people and their use of space within a village.

Excavations at the Reinhardt Site

The property on which the Reinhardt site is located has long been used for modern cultivation (at least since the 1930s) and has been inundated frequently by collectors in search of prehistoric artifacts (Nolan 2010:37-38; Roos and Nolan 2012:26). Despite this, formal archaeological excavations revealed that features were intact, exhibiting only expected plow damage (Nolan 2010). The initial organized excavation at the Reinhardt site was conducted by Mike Ohlinger and James Morton in 1988. Their excavations were limited (only fully investigating one pit feature); however, their surface investigations determined the approximate village boundaries (Nolan 2010:37-38).

Beginning in 2007, Drs. Burks, Dancey, Roos, and Nolan introduced the non-invasive methods of gradiometery and magnetic susceptibility surveys to the Reinhardt Site. Analysis of the resulting geophysical maps showed circular spots that differed from the surrounding landscape. Using these readings, Burks, Dancey, Roos, and Nolan compiled a list of 136 separate areas of possible cultural activities. These 136 areas were termed anomalies (Nolan et al. 2008; Nolan 2009, 2010:105). Of these, 16 have been excavated and represent ritual features, possible structures, household activity zones, and trash deposits. On the surface and within the excavated features, debitage is the most abundant artifact present, followed by organics, ceramics, and other lithic artifacts (Nolan 2010). During surface collections conducted in 1988 by Mike Ohlinger and James Morton and then again in 2007and 2008 by Drs. Nolan, Burks, Dancey, and Roos, debitage indicated certain pockets of high activity (Nolan et al. 2008; Nolan 2009, 2010). Subsequently, when geophysical surveys were used to identify buried features, positive and strong magnetic readings (indicating cultural anomalies) often matched the lithic scatters (Nolan 2010). Therefore, well before my analysis, a relationship between debitage and features had already been established. In this light, I decided that using specific anomalies/features and their relationship with debitage would be a useful form of analyzing use of space on the site.

Research Questions

How people use and interact with space is evidenced archaeologically by repeated patterns of artifacts, structures, or monuments within villages and across regions. Three popular methods applied to use of space studies include: identifying activity zones using lithic debitage density (Zvelebil et al. 1992), plotting the spatial relationship between artifacts and ritual features (Cook 2008:150-151), and analyzing social relations by identifying repeating patterns of artifacts and features (Means 2007:156-158). I use these methods and lithic debitage to identify varying activities occurring in different feature types before comparing the datasets against each other to determine patterns of activities across the site. By applying these methods, I was able to address my core question: how did prehistoric residents at the Reinhardt site view and use their space.

My research provides evidence which indicates designation of space for specific lithic activities, a standardization of technological methods, and a marked difference in lithic technology between two separate occupation episodes. My investigation was structured by three research questions:

1. Did stone tool production vary by feature function (hearth, structure, midden, etc.)?
2. Do debitage attributes and debitage density vary geographically across the site?
3. What do significant differences (or lack thereof) in debitage attributes among features and across space imply about village layout?

Definitions

It is important to understand the terms and definitions used in my research. These include debitage, flakes, cortex, production stage, and archaeological features. **Debitage** is the excess, unused, unmodified lithic waste created during a reduction process (Andrefsky 2001:xi; Sievert and Wise 2001). The manufacture of one stone tool can create thousands of debitage pieces. Debitage is generally stationary, meaning people did not carry it from one site to another as they would with most stone tools. Debitage is located either where it was created or nearby in a trash deposit. Unlike organic tool waste of bone, shell, or wood, debitage resists deterioration. For these reasons, it has been used to identify a large percentage of prehistoric sites across the world and, like Reinhardt, often constitutes the highest percentage of artifact types found on a site (e.g., Andrefsky 2001:2; Barber 1978:192; Cotterell and Kamminga 1987:675).

Stone tool production is a reductive process; meaning it begins with something large (e.g., a core) and is reduced to something smaller (e.g., projectile point). Theoretically, this suggests that the production waste also decreases in size during manufacture. For example, large flakes are associated with early stage production and small flakes indicate later stage production. During the manufacturing process, rocks can break unexpectedly which can in turn produce a type of excess called **angular shatter.** High percentages of angular shatter in a collection are indicative of cobble testing or early stage reduction. High percentage of shatter can also indicate that villagers were refining materials at Reinhardt as opposed to the site of procurement (Cobb 2003; Kohler and Root 2004; Root 1997; Sullivan and Rozen 1985; Whittaker and Kaldahl 2001:58).

Another indicator of production stage is amount of **cortex.** Cortex is a rock's weathered, exterior surface (Figure 4). Cortex is generally different in texture and/or color from a rock's core (interior). The amount of cortex on a flake can be indicative of the reduction stage. Often, cortex removal is the first step in manufacturing stone tools. Cortex is located on the dorsal (exterior) side of a flake and the ventral (interior) side is free from cortex.

The nature of lithic debitage (size, amount of cortex, etc.) depends upon the technology used and the type of tool being produced (Andrefsky 2005:114). The amount and characteristics of debitage (measurements, weight, nature of flake scars, etc.) often correlate to specific activities (Amick et al. 1988; Austin 1999; Bradbury and Carr 1999). For example, high proportions of angular shatter in a collection are indicative of early stage reduction or cobble testing (Root 1997; Sullivan and Rozen 1985; Whittaker and Kaldahl 2001:58). If mixed assemblages and variability of raw material are controlled for, mass analysis (size grading of debitage) is useful in reduction stage analysis (Andrefsky 2007:398). Amount of cortex (weathered outer surface of a rock) present on a debitage flake can reflect the stage of reduction (Sullivan and Rozen 1985).

An **archaeological feature** is a human-made or modified structure or artifact that cannot be removed from the excavation site without losing its integrity (Arkush and Sutton 2006:358). To effectively answer questions concerning activities at certain feature types across a space, it is useful to have a sample which includes a variety of activity contexts. The Reinhardt site is ideal because it contains numerous types of features (Nolan 2010). The types of prehistoric features highlighted in this research are related to habitation activities such as hearths, midden (trash) deposits, and structures.

Methods Overview

Methodologically, I chose to analyze debitage in two steps. First, the debitage collection from each selected Reinhardt feature was analyzed to identify quantity and variability which might specify the activities associated with a specific feature type (hearths, midden pits, etc.) (Andrefsky 1998, 2001; Cowan 1999:600; Hayden et al. 1996).

The second step is comparison of debitage among features. The comparison helped build a relationship between activities and specific features. This step allows me to construct a pattern of activity. Did the inhabitants of Reinhardt prefer to accomplish specific flintknapping tasks at specialized locations in a village? Did they view certain features or locations within the site as superior for accomplishing these jobs? Following the example of Hull (1987) debitage comparison among features identified if there was a pattern among some features based on certain activities.

Justification

A paucity of research, a substantial collection of debitage, and previously tested methods provided the foundation needed to conduct this investigation. In answering my research questions, I address ideas concerning association between activities and features, and use of space. An understanding of how people used their space can provide insight into social structure and power dynamics within the community (Knight 2010:348; Zvelebil et al. 1992). In addition, my research serves as a tool for future archaeological site and debitage analyses.

CHAPTER II: Literature Review

Historical Development of Fort Ancient

As previously stated, Reinhardt is a Late Prehistoric village that dates from A.D. 1220 to A.D. 1400. Because of its temporal and geographic position, the Reinhardt site is associated with the Late Prehistoric period which falls into the arbitrary archaeological culture termed "Fort Ancient." As with other archaeological culture periods, the term "Fort Ancient" impacts some ideas and stereotypes surrounding Reinhardt and other Late Prehistoric villages in the region. These include, but are not limited to, site layout, artifact types, mortuary practices, political structure, and subsistence practices.

My concept of the Fort Ancient culture is most in-line with recent literature concerning the disadvantages of grouping sites into arbitrary phases and the very idea of a "Fort Ancient" classification (e.g., Brady-Rawlins 2007; Nolan 2010; Nolan and Cook 2011). Although it is necessary to understand the following literature pertaining to this time period associated with Reinhardt, it is important to note that my research attempts to exclude preexisting ideas concerning broad cultural categories such as Fort Ancient.

During the first half of the twentieth century, archaeology in the Middle Ohio River Valley (MORV) was extensively studied and known throughout the United States (Griffin 1966:1). The term "Fort Ancient Culture" was first introduced in the early 1900s by William C. Mills and was associated with prehistoric peoples in Ohio, West Virginia, and Kentucky (Henderson 1992). After the term was coined, many theories concerning Fort Ancient people emerged including the hypothesis that they were Hopewell ancestors (Griffin 1937, 1966). Ideas concerning Fort Ancient varied and were inconsistent until the 1940s when James Griffin compiled his impressive volume, *The Fort Ancient Aspect.* Griffin organized the associated sites by space and artifact types. Griffin's work is still significant to current research in that many archaeologists refer to his typologies (e.g., Henderson 1992:3). The latter half of the twentieth century has seen additions and modifications to the definition of Fort Ancient including broadening its geographic borders, adding new artifact types, and introducing new phases (Cowan 1988; Drooker 1997; Graybill 1981; Pollack and Henderson 1992).

In contrast to Griffin (1966) who creates cultural labels through space, Prufer and Shane (1970) organized Fort Ancient categories primarily using temporal information. Currently, Fort Ancient is divided into three periods: Early Fort Ancient which spans A.D. 1000/1050 to A.D. 1200/1250; Middle Fort Ancient which spans A.D. 1200/1250 to A.D. 1400/1450; and Late Fort Ancient which spans A.D. 1400/1450 to 1650/1670 (Drooker 1997:69). These divisions are largely arbitrary and vary slightly among authors (Cowan 1987; Essenpreis 1982; Graybill 1981; Henderson 1992; Prufer and Shane 1970). Traditionally, the temporal divisions among Early, Middle, and Late Fort Ancient are marked by visible change in features and artifacts (Drooker 1997:5). However, recent research questions the validity of these divisions and they should not be viewed as absolute (Nolan 2012).

Further dividing Fort Ancient are divisions called foci or phases defined by geographic and artifactual criteria. Griffin (1966), using space as separation, was the first to define four main foci within Fort Ancient: Baum, Anderson, Feurt, and Madisonville (Henderson 1992:11). Griffin (1966) notes that the differences in the Central Ohio foci can be seen in criteria such as effigies, mortuary practices, and the nature of artifacts (primarily ceramics). Since the publication of Griffin's book, phases have been redefined and added (Cook 2008:34; Drooker 1977:64-70; Henderson et al. 1992; Prufer and Shane 1970).

Fort Ancient Characteristics

With the creation and evolution of what it means to be Fort Ancient, a set type has been developed pertaining to site layout, subsistence practice, social structure, mortuary practice, and use of space (Cook 2008; Drooker 1997; Griffin 1966; Henderson 1992). The following are some of the more current and widely accepted trends; however, these concepts are becoming increasingly challenged as the amount of data increases and new forms of data are analyzed.

A popular model asserts that Fort Ancient settlement patterns undergo a shift between the Early and Late periods. Both periods are marked with the presence of established homes but during the Early Fort Ancient period, sites are mostly limited to hamlets with usually no more than six structures (Cook 2008:34, 41). Late Fort Ancient villages are larger, circular, and often accompanied by stockades (Cook 2008:34-35). According to Pollack and Henderson's (1992) model, anomalies and artifacts are patterned in a circle and situated around a mostly pristine central plaza. Most surveyed or excavated Fort Ancient villages show this ring of activity area with a central open plaza (Nolan 2010:31, Table 7.1).

Subsistence practices throughout Fort Ancient varied slightly. The shift from the Late Woodland period to Fort Ancient is characterized by increased agriculture especially in cultivation of maize (Wagner 1987:1). In addition to maize agriculture, most Fort Ancient villages exhibit evidence of other gardening supplemented by gathering of wild vegetation and extensive hunting (Wagner 1987:3). With the increase in maize agriculture comes an increase in food storage pits (Cook 2008:41).

The social structure within Fort Ancient villages appears to be egalitarian (Cook 2008:37; Henderson and Pollack 1992). The primary indicator of this is found in burials which indicate a difference between sex and age but not social status. Burial mounds are present in the Early and Middle Fort Ancient but are absent in Late Fort Ancient sites (Brady-Rawlins 2007; Cook 2008:37).

Most useful to my thesis is how researchers interpret Fort Ancient use of space. While use of space at other sites does not necessarily transfer to Reinhardt, it is helpful to examine how researchers use archaeological data to interpret human behavior at sites.

Late Prehistoric Use of Space

Archaeologists have long looked at use of space and activity patterns to make inferences about prehistoric societies. Examining the way prehistoric people divided and used their space can determine political structure and social classes (Knight 2010:348). Conceptualization of space is important in any archaeological research project that examines activity patterns or site layout. Michel Foucault, who wrote about concepts of space, notes in one of his interviews with Paul Rabinow that the relationship between space and power are fundamental in communities (Foucault 1984:252).

Early in spatial studies, archaeologists focused primarily on the objects and features with little emphasis on interpreting or understanding the people who used and created them (Ashmore 2002:1174). However, more recently, archaeologists have begun including social theory with spatial analysis (Ashmore 2002:1180). Some of the more advocated methods for examining space are mapping of lithic scatters to determine activity zones (Zvelebil et al. 1992), proximity of artifacts and structures to ritual features to infer intrasite power structure (Cook 2008:150-151), and analysis of social relations through examination of geometric patterns (Means 2007:156-158).

Zvelebil et al. (1992:215) state that use of space is reflected in the concentration and variation of artifacts. In their case studies, Zvelebil et al. compile data from the Mesolithic and Neolithic time periods throughout certain regions in Ireland. Their results identify manufacturing areas and habitation zones which reflect major shifts in socio-economic structure typical of the time period during the shift from hunting/gathering to farming in Ireland. It seems obvious to predict that concentration and density of debitage would vary across sites (including those in the MORV like Reinhardt) because humans' behavior and subsequently their material remains are constantly changing to reflect political, economic, and social structure.

Cook (2008:150-151) identifies activity zones and habitation areas and then charts their proximity to important site features such as the central posthole in a Fort Ancient village, or solstice alignments. He uses this method to infer power relations. For example, at the SunWatch site in Ohio, he identifies the village leader residence by its close location to the central plaza post. In addition, after defining the boundaries of residential zones, he hypothesizes that each zone encompassed a distinct corporate group. Reinhardt, like SunWatch, may exhibit a clean central plaza. As such, recording the location, density, and variety of debitage in relation to the plaza (which is part of my Reinhardt analysis) is a meaningful method of analyzing use of space.

Bernard Means (2007:157) notes that "physical dwellings serve to anchor people in space and time." He uses dwellings and artifacts associated with, or located near dwellings to identify the presence and power of corporate social groups (Means 2007:157). This method of analysis is especially important with the data related to A19, A80 and Trench 1 at Reinhardt which are associated with probable structures. While debitage alone and a single house feature cannot tell us about power or social groups, the data recorded for A19, A80 and Trench 1 provides a stepping stone for such future research.

At Reinhardt, lithic debitage is present in every feature. My thesis is a rudimentary step in processing questions such as who controlled the space in which these debitage clusters are found, who decided where tools should be made, or where debris should be deposited. Rather than focusing exclusively on interpretation of lithic activities, I use this work to highlight overarching theories concerning use of space.

Debitage Analysis Literature

Village sites which are occupied for long periods of time are expected to exhibit debitage which is a mixture of early and late stage lithic reduction and production. It is also expected, especially at sites like Reinhardt where inhabitants rarely traveled for lithic resources, that debitage from retouching will be abundant (Ahler 1989:106)

George Odell (2001) addresses many current issues in lithic debitage analysis. Closely related to the objectives of this thesis, he discusses how midden, especially lithic debitage, varies across sites. Odell mentions the research done by Cowan (1999) in which Cowan uses debitage to support the idea that different technologies were being used across different time periods. Odell also points to studies by Fedick (1991) in which debitage analysis was used to locate chert workshops in addition to determining stone tool production and use at household sites.

The idea of variability in lithic technological organization (i.e., specific debitage characteristics associated with specific activities) applied in this thesis comes from extensive research by scholars such as Andrefsky (1998, 2001), Shott (1994, 2000), Mauldin (1989), Magne (2001), Whittaker and Kaldahl (2001). Through measurement, microscopic, and macroscopic analysis and comparison, debitage can be used to determine what lithic activities were being performed at specific locations (Root 2004:65). In debitage analysis, there are two main perspectives. First is an individual artifact perspective which focuses only on single flake characteristics to identify a specific activity. Second is population perspective which looks at an entire assemblage to understand behaviors taking place at a site (Andrefsky 2005:113). More about the use of both these perspectives in this research can be found in the methods section.-

Mass Analysis

A popular method in the population perspective is aggregate analysis. Stanley Ahler (1989) supports individual flake analysis but favors the method of aggregate analysis (specifically mass analysis) when dealing with large debitage collections such as those typical of intensively occupied villages. He focuses on mass analysis (MA) because it is the most widely used method for aggregate debitage analysis (Ahler 1989:87). He notes there are many benefits to using this method. First, MA can be used to analyze all flake types including flake shatter and therefore does not limit a collection to only whole flakes.

Second, it is a relatively quick and straight-forward approach when dealing with large collections. Third, it protects against technological biases by including all flake sizes including those created by pressure flaking (Ahler 1989:87-88).

Interpretation of mass analysis is based on two principal ideas. First, flintknapping is a reductive activity (theoretically, this means large pieces are associated with the beginning of the process and smaller pieces are indicative of a later stage). Second, different tools and different manufacture practices will produce different debitage types (Ahler 1989:89). Because it is a popular method, mass analysis is often overused and misapplied in lithic research which has led to hasty and inaccurate interpretations (Andrefsky 2007:393). Mass analysis can be riddled with error when attempting to identify specific technologies or reduction stages from mixed assemblages (Andrefsky 2007:396). When attempting to identify tool type through debitage, the analysis can be either inaccurate or redundant (Andrefsky 2007:399).

Root (2004:65) argues that MA alone is not a reliable method for interpretation of lithic activity. He asserts that some form of attribute analysis be used in conjunction with MA in order to make it useful. One such method is recording the amount of dorsal cortex on flakes. I use MA and amount of dorsal cortex to gain a sense of where similarities and differences in lithic production activities occur across the Reinhardt site. Further discussion about the objections and justifications of MA can be found in the Methods chapter.

Amount of Dorsal Cortex

There can be many flaws with this method because the amount of cortex does not always correlate to a specific activity. The type of tool being produced, objective piece size, knapper, and production technique can all affect the amount of cortex found on debitage (Andrefsky 2001:11). However, while not applicable to all collections, amount of cortex can give researchers a rough estimate concerning reduction stages.

Amount of cortex and flake size are complimentary and, when used in combination, can control for errors that occur in studying only one or the other (Mauldin and Amick 1988). Wilmerding and Kay (2011) used amount of dorsal cortex on debitage as an indicator of state of manufacture. They compared debitage collections from six pits located at different sites to make inferences about lithic production activity.

Quantification of Debitage

Quantification or counts of lithics on a site is a method which can be used to help determine population size, differences in behavior, length of occupation, and scale of lithic use on a site (Shott 2000:725). Milne (2009) notes that the quantity of flakes can directly correlate to occupants' activities and their use of the site. This is because during the production of stone tools, debitage falls in close proximity to the place of manufacture. In some cases, debitage may be moved to a waste zone or trash pit but these are generally near the site of manufacture. Because of the nature of its production, debitage works well with quantification analysis. Quantifying (counting) debitage can help refine information about the number of tools used on a site rather than just attempting to count the tools themselves (Shott 2000:736). As mentioned previously, the extent of debitage analyses in MORV is mostly limited to quantification.

Late Prehistoric Lithic Analyses

As late as 2011, Wilmerding and Kay (2011:52) noted a paucity of debitage studies in some areas. Lithics at Reinhardt and other regional Late Prehistoric villages have been analyzed, but minimal research using debitage has been conducted. This is a problem because debitage is the most abundant artifact found at Reinhardt and based on debitage studies conducted outside the MORV, debitage contains a wealth of cultural information. The MORV exhibits many Late Prehistoric sites which are attributed to the arbitrary Fort Ancient culture group (Baby et al. 1964; Baby and Potter 1965; Barber 1978; Brady-Rawlins 2007; Cook 2008; Drooker 1997:66; Griffin 1966; Henderson 1992; Nolan 2010; Prufer and Shane 1970; Seeman 1985). While using debitage analysis from Late Prehistoric sites in the MORV is scarce, some studies have been conducted.

At Blain Village on the west bank of the Scioto River, Olaf Prufer and Orrin Shane (1970) uncovered forty-seven features which included various shaped refuse pits, shallow midden deposits, and hearths during their excavations. In the chapter which discusses each feature in detail, there is no analysis of debitage (termed chippage by the authors) other than a report of each feature's flake quantification. Prufer and Shane (1970:75) mildly criticize the lack of lithic analysis at the nearby and similar sites of Baum and Gartner in Ross County. They dismiss their own lack of unmodified debitage analysis due to the shallow site depth, the negative impact of cultivation, and alluvial flooding. The lone feature debitage collection used to gain cultural information at Blain Village is associated with Feature 11. Prufer and Shane analyzed 32 flakes from a single core located in the feature to infer that a hard hammer technique was used at this location to produce some form of stone artifact. Aside from this, no debitage study is conducted outside of material comparison and striking platform analysis. Especially with their conclusions from striking platforms, the authors offer no data or statistical results to support their claims. Instead, they make broad statements about stages of manufacture but their failure to define or explain their methods weaken the significance of their conclusions (Prufer and Shane 1970:107-108).

Russell Barber (1978) performed analysis on a lithic assemblage from the Anderson Village site in Warren County, Ohio within the Little Miami River drainage. Although Barber had a sizeable amount of debitage in his collection, his analysis of the debitage went only so far as to infer that the industry which created the waste (pebble and small stone specimens) points to conservation of chert. The majority of his analysis focused on lithics related to tool use, such as blades, bifaces, scrapers, and drills. In his conclusion, Barber makes a plea for more thorough lithic analyses of Fort Ancient culture period sites.

Some researchers attribute the Baum and Gartner sites to the same phase (Baum phase) as Reinhardt. The Baum and Gartner sites are located in Ross County, Ohio and, like the Reinhardt site, are situated in the Scioto River drainage basin. In his volume, *The Fort Ancient Aspect,* Griffin (1966), dedicates most of a chapter to these sites describing their artifact assemblages in rich detail. He notes the tools used to create debitage (hammerstones, billets, etc.) and how, around structure features, as many as twenty-five to thirty of these tools can be found. Based on this, it seems plausible that large debitage collections will be found in or around structure features. Because many collections did not include debitage, Griffin records only stone tools.

Closely related to my research is analysis of unmodified flakes at the Locust Site (33MU160) located in Muskingum County, in Central Ohio. Seeman (1985) examines the large debitage collection (17,221 flakes) in part to identify functions of the site and specific features. Before Seeman's analysis, diagnostic artifacts had been used to identify the site as Hopewell; however, Seeman uses radiocarbon dating and detailed analysis of diagnostic artifacts to date the primary component of the site to the Late Prehistoric period. Using a form of mass analysis, Seeman analyzes unmodified flakes by constructing a weight to number relationship across proveniences. The similarities in this relationship, combined with their moderate size, and the characteristics found in bifaces show that a principal activity at the site may have been secondary lithic reduction. In addition to identifying site function, he uses his analysis to infer information about specific features. His report shows that among features of similar size, Features 20, 21, and 23 produced more debitage than the others. This indicates that these features were locations of more activity. The major limitation in Seeman's analysis is that he provides no statistics to back his claim for a relationship between weight and number, nor does he define what parameters were used in defining "moderate size".

The O. C. Voss site is located in Franklin County, Ohio just north of Reinhardt in the Scioto River drainage. As with many other regional investigations, work at the Voss site does not put much emphasis on debitage. There have been two formal excavations at the Voss site. One took place in the 1960s and focused exclusively on the Voss Mound (Baby et al. 1964; Baby and Potter 1965). This excavation was primarily concerned with identifying a Fort Ancient component, and analyzing ceremonial artifacts and mound features In the second investigation, Brady-Rawlins (2007) does address some complex questions, but she does little more with debitage than quantify the collections. Although debitage analysis is limited here, characteristics of the O.C. Voss site are relevant. Voss is in the same region as Reinhardt and is characterized as Fort Ancient. The patterns between features and artifacts and the site layout bear some similarities to Reinhardt.

Lithic Tools at Reinhardt

Although Fort Ancient and its phases are generally denoted by material categories using ceramics, lithic tools vary as well (Church 1987; Graybill 1981; Railey 1992). It is useful to have a general idea of what tools were found at Reinhardt and which tools were manufactured during the Late Prehistoric period in the MORV. It is from the production of these tools that the studied debitage resulted. Some of the tools at Reinhardt resemble lithic projectile point types such as Lamoka, Brewerton Corner Notched, Kirk Stemmed, Robbins, and Jacks Reef Pentagonal. Lamoka points have a trianguloid shape with a hafting element and are relatively small (Justice 1987:127). Lamoka points date to the Late Archaic and, while not common in the Ohio Valley, they are present (Justice 1987:129). Brewerton Corner Notched points are trianguloid and exhibit a hafting element and, like Lamoka, they are attributed to the Late Archaic. Pressure flaking scars are rarely present on Brewerton points (Justice 1987:115). Kirk Stemmed point types are associated with the Early Archaic and exhibit a corner notch hafting element (Justice 1987:82-83). Robbins types exhibit straight stems and are usually associated with the Early Woodland period. Their shape and edges vary slightly by age and region (Justice 1987:187-188). Jacks Reef

Pentagonal types are pentagonal in shape and lack notches. They are associated with the Late Woodland period and are found throughout Ohio (Justice 1987:215). Although these points date to earlier periods than Reinhardt's main occupation, it is expected that if the tools themselves were not produced at Reinhardt, at least some of the debitage can be associated with them from reshaping or sharpening.

Most relevant to the Late Prehistoric period are Madison and other untyped Late Prehistoric point types (Nolan 2010:348). Madison points are shaped in isosceles triangles and have no stem. They are characteristic of the Late Woodland and Mississippian periods and are common throughout the Eastern United States (Justice 1987:225, 227). The other points, as described in Nolan's Reinhardt database, are Late Prehistoric triangular points which were not typed.

The Reinhardt Site

Insight into social structure can be inferred by identifying activities at habitation sites (Means 2007; Nolan 2011:113). The Reinhardt debitage samples analyzed come from features of varying types. In 2008, Burks, in conjunction with Nolan, conducted a gradiometry survey and a magnetic susceptibility survey during which they identified over one hundred magnetic anomalies and possible features at Reinhardt (Nolan et al. 2008; Nolan 2009). Almost all the anomalies/features, whether directly in their fill, on their surface, or in their plow zones, contain debitage collections (Nolan 2010). Although later Fort Ancient villages tend to be larger and non-circular, Reinhardt data show that the site is consistent with the general pattern of Pollack and Henderson's (1992) model. In addition, social complexity increases from Early to Late Fort Ancient (Pollack and Henderson 1992).

Some Fort Ancient village sites exhibit a pattern consisting of a refuse (midden) ring located outside a ring of structures (Pollack and Henderson 1992). The proximity of selected Reinhardt features in relation to this donut-shaped intrasite layout provides context to specific debitage samples.

The primary analysis of Reinhardt data was conducted by Nolan during various investigations spanning 2007 – 2009. Some of Nolan’s studies were conducted in collaboration with other archaeologists (Dancey et al. 2009; Nolan et al. 2008; Roos and Nolan 2009). The site background information and the debitage collections I use in my research are results of Nolan’s fieldwork.

CHAPTER III: Methods

Debitage analysis is important, in part, because there is a lot of it. Why wouldn't the most frequently found artifact on many sites across the world be critical to our understanding of the cultures that created it? Replication studies and accounts of historic stone tool production (Holdaway and Douglass 2011:6) report that roughly two-thirds of material was "tossed" during the process of manufacturing a single tool.

The key to debitage analysis is to employ methods that control for errors and test results with statistics. Many debitage analyses are based on dated models which, despite their inaccuracies, are still prominent in today's methods. The following methods are employed to construct broad ideas concerning activity patterns and, subsequently, use of space at Reinhardt. Specifically, they are used to answer the three research questions posed in my introduction: 1) Did stone tool production vary by feature function (hearth, structure, midden, etc.)? 2) Do debitage attributes and debitage density vary geographically across the site? 3) What can be inferred about village layout from significant differences (or lack thereof) in debitage among features and across space?

Sample Selection

As mentioned earlier, anomalies identified by Nolan (2010) refer to readings of subsurface contexts found through geophysical surveys. In total, 136 anomalies are identified and discussed by Nolan (2010:237). Nolan classifies anomalies by size of anomaly and the strength of magnetic susceptibility/remanent magnetism reading. He defines nine groups of which the following seven contain debitage: small/medium; small/low; small/high; medium/medium; medium/low; medium/high; large/medium.

Nolan notes that he excavated a sample of 13 of the 136 anomalies (Nolan 2010:163). Nolan also opened three subsurface trenches.

For the purpose of this research, I selected debitage collections from a sample of nine anomalies and one trench section. My sample of nine anomalies constitutes 69percent of all excavated anomalies. Collectively, the nine anomalies and one trench section encompass sixteen distinct features (Table 1). This sample was not chosen randomly but instead was selected to meet three criteria. First, the sample covers the spread of the site and attempts to not overrepresent one geographic section (Figure 5). Second, the features within the sample represent a variety of projected functions, for example, possible structures, midden deposits, a hearth, and a storage pit. Finally, when possible, I chose anomalies in different size/density categories as defined by Nolan (2010). Still, A80 and A6 (small/low category), and A10 and A47 (small/medium category) shared size/density designations. A80 encompasses the only excavated feature located inside the perimeter of a ditch feature (Nolan 2010:233) and likely predates the rest of the site. Therefore, although it shares a size/density category with A6 (Nolan 2010:69), it was chosen in order to include a feature associated with the enclosure. A10 is the only feature which represents the center of Reinhardt, and A47 contains the deepest feature (F6) and a large amount of debitage. Both of these characteristics outweigh their shared size/density category.

Each sampled anomaly was fitted with center point coordinates and the northwest quarter of the anomaly was excavated (Nolan 2009:66). Results from excavations and surveys indicate the widest activity zones are located on the southeastern side of the village (Nolan 2009:375). A sample of the excavated anomalies that proved to be cultural, and the features located within the anomalies, are the source of my debitage collections.

The following section identifies and discusses the specific features and/or anomalies from which the analyzed debitage was collected.

Trench 1

In 2008, part of a subsurface excavation included four $4m^2$ units. The units span from N1094 to N1102 running along the E972 line, and are collectively called Trench 1 (Nolan 2010:67, 204). Inside the N1100 $4m^2$ unit, two features were identified. F9/08 consisted of a shallow oval stain full of fauna and carbon (Nolan 2010:214). F12/08 (within Trench 1) appeared to be a postmold which is possibly part of a structure that stood along the E972 line (Nolan 2010:229). The majority of lithic artifacts recovered in N1100 came from outside the unit's two features and, in contrast to the other units in Trench 1, a plurality of the lithic artifacts consisted of debitage (Nolan 2010:214). In my research, Trench 1 refers only to the $4m^2$ unit at N1094. In total, 707 flakes and flake shatter, and 82 pieces of angular shatter were analyzed.

Nolan (2010:229) notes that the three excavation trenches, including Trench 1, provide insight into prehistoric activity patterns at Reinhardt such as settlement structure, community organization, low artifact counts in relation to structure interior, and the probable change of organization of space over time. He also notes that if Reinhardt was constructed in a circular pattern, like some Late Prehistoric villages in the region, Trench 1 could have been located within the habitation ring during early occupation, and inside the midden/burial ring during later occupation (Nolan 2010:230). Nolan supports this repositioning from habitation ring to midden/burial ring with the two most extreme dates found by Accelerator Mass Spectrometry (AMS) results (Nolan 2010:335-336).

Anomaly 6 (A6)

This anomaly falls in the small/low category. It is located on the western side of the site. An excavation unit was opened and one feature (F8/08) was identified which spanned almost the entire anomaly. The feature was documented as a shallow (50 cm maximum depth) trash pit which yielded few artifacts. Most debitage was found in the plow zone. (Nolan 2010:164). Altogether, 83 flakes and flake shatter, and 0 pieces of angular shatter were analyzed.

Anomaly 132 (A132)

Large/medium anomalies are represented in my sample by A132. It also represents the southern portion of the site. F6/08, F7/08, and F14/08 are the three features located inside A132, however, F14/08 is likely a rodent burrow. F6/08 and F7/08 are midden filled pits (Nolan 2010:198). F6/08 (located within A47) is the deepest excavated feature at Reinhardt and at 185 cm includes articulated dog remains. Altogether, 418 flakes and flake shatter, and 28 pieces of angular shatter were analyzed.

Anomaly 77 (A77)

A77 is in the medium/medium category and represents the southeastern area of the Reinhardt tract. Surrounding A77 are three additional medium anomalies, however, A77 is the largest and includes three features (Nolan 2010:193). Nolan interprets the high density of FCR beneath the plow zone in the anomaly as a cooking feature which has not been assigned a feature number. F16/08 and F17/08 are midden pits (Nolan 193-194). Very little lithic material was found below 55cm in the anomaly and features (Nolan 2010:195). 695 flakes and flake shatter, and 116 pieces of angular shatter were analyzed.

Anomaly 19 (A19)

Small/high anomalies and the southwest portion of the site are represented by A19. Three post molds (F22/09 – F24/09), a possible pit (F21/09), and a deep (162 cm) bell-shaped pit which include ash and earth from cleaning a nearby fire pit (Nolan 2010:178-180). This anomaly is located inside of what most likely constitutes the remains of a house with associated storage/midden pits (Nolan 2010:179). Soil flotation from this anomaly conducted for this investigation produced the first and only corn cob found on the site to date inside Feature 20/09. In total, 404 flakes and flake shatter, and 71 pieces of angular shatter were analyzed.

Anomaly 124 (A124)

A124 is classified as a medium/low anomaly and contains one feature (F34/09). F34/09 is characterized by its difference in soil texture from the surrounding area. It is described as a shallow pit with minimum debitage and appears to be a low activity zone (Nolan 2010:183-185). From this anomaly, 150 flakes and flake shatter, and 45 pieces of angular shatter were analyzed.

Anomaly 80 (A80)

A80 falls inside the perimeter of the Peters Square (33PI917) ditch located at the northern portion of the site. Peters Square ditch (highlighted in red in Figure 5), is a

Woodland period earthwork that appears to predate the other features selected for my research. This earthwork, along with Campbell Circle (PI1013) is associated with a Woodland period habitation site (Nolan 2010:379). Debitage from A80 is the only collection that predates Fort Ancient. A80, along with A120 (not used in my research sample), challenges the idea that most excavated material at Reinhardt comes from the Late Prehistoric period. Nolan (2010:231-233) states that it is unlikely any activity occurring inside the confines of the Peter's Square Ditch is related to the Late Prehistoric time period.

The 4m^2 excavation unit opened in A80 yielded four features (F43/09 – F46/09). F45 and F46 are large possible post molds. F43/09 is identified as a rodent disturbance, however, it is later noted that shatter and flake throughout the feature leave its function unknown (Nolan 2010:168). Altogether, 326 flakes and flake shatter, and 117 pieces of angular shatter were analyzed from A80.

Anomaly 10 (A10)

A10 is in the small/medium category with a low activity function and no associated features. It is the only anomaly which produced primarily lithic material, most of which was found beneath the plow zone (Nolan 2010:176-177). From A10, 105 flakes and flake shatter, and 3 pieces of angular shatter were analyzed.

Anomaly 47

Like A10, A47 is in the small/medium class and represents the extreme western border of the site. It encompasses three features (F31/09 – F33/09) which are associated with human burials, a pit, and a midden with articulated dog remains. Although these features were disturbed in the 1980s during excavations by Morton and Ohlinger, the anomaly still yields a sizeable amount of debitage. Because there is a relatively large collection of debitage recovered (Nolan 2010:172-176), it is still used in this analysis. I analyzed 698 flakes and flake shatter, and 116 pieces of angular shatter.

Anomaly 69

A69 is included in the medium/medium category and has one feature (F23/09). The feature and surrounding area exhibit high frequencies of burned earth and FCR. The patterns and stratigraphy indicate the presence of midden and an *in situ* burning episode (Nolan 2010:185-187). In total, 441 flakes and flake shatter, and 60 pieces of angular shatter were analyzed.

Debitage Collections

The collections used are from the 2008 and 2009 field seasons led by Nolan (2009, 2010). Using a strictly intrasite comparison (meaning the Reinhardt debitage is compared only within the collection) helps eliminate the influence of preexisting categories connected with Fort Ancient or Baum Phase typologies (Andrefsky 2005:5). The total number of individual debitage pieces including flakes and angular shatter used in my research is 3808. The original quantity was higher; however, in some samples, several of the flakes or shatter were omitted because of duplicate labels, outliers, and missing or unmarked specimens (one example is FS390 from Trench 1 where only 402 relevant artifacts of the original 435 were analyzed).

Ideally, inferences about lithic activities should be made from a combination of methods (Root 2004:65-66). The more debitage attributes analyzed, the more accurate the interpretations. Root (2004) suggests combining mass analysis with multiple attributes including flake scar count, platform type, size, or cross section, among others. In addition to deriving information from flake to angular shatter ratios, each flake's, material type, size, and amount of dorsal cortex were analyzed in my research. I am aware that my data would be more complete with inclusion of additional flake attributes; however, my methods are appropriate to the question, constitute an efficient way to address these questions, and recording all attributes was beyond the required scope of this project.

Quantification

As stated in the literature review, the extent of debitage analyses in Middle Ohio River Valley (MORV) is mostly limited to quantification. Milne (2009) notes that the quantity of flakes can directly correlate to occupants' activities and their use of the site. By itself, this method does not answer my research questions; however, it does say something about stone tool production zones and depositional practices. In some cases, areas which exhibit much higher counts of debitage indicate either increased levels of stone tool production or depositional zones. Quantification also provides a broad picture of the scale (size amount) of the collections used. Following the process used by Whittaker and Kaldahl (2001) the entire sample (from all features/anomalies) was counted and weighed collectively. Then, each sample from an anomaly was counted and weighed. Finally, every individual sample from a single feature was counted and weighed.

Raw Material

The first step in my attribute analysis was to sort all debitage collections within features/anomalies by raw material. This controls for error produced when the nature of debitage differs by material not activity (Amick and Mauldin 1989; Andrefsky 2006; Wilmerding and Kay 2001). Because raw materials break differently, material type can influence the ratio of flakes to shatter, and the size of debitage. Using two comparative collections from Ball State University and macroscopic analysis, seven material types were recorded: Brush Creek, Burlington, Delaware, Flint Ridge, Unknown, Upper Mercer, and Wyandotte. In the Reinhardt database compiled by Nolan (2010), unidentifiable material types were separated by "unknown glacial" or "unknown exotic". In my analysis, these two categories were combined under one label called "unknown".

Percentage of Shatter

The next step was to identify and count (quantify) the pieces of angular shatter in each sample. Each of the ten samples was analyzed for presence of angular shatter and the percentages calculated. High proportions of angular shatter (which is recorded in this study) can indicate a cobble testing or very early stages of reduction (Root 1997; Sullivan and Rozen 1985; Whittaker and Kaldahl 2001:58) and is especially indicative of core reduction (Cobb 2003). Kohler and Root (2004) note that high percentages of shatter indicate knappers were bringing minimally worked cobbles into the village to refine. Amick and Mauldin (1989) argue against Sullivan and Rozen (1985) insisting it is primarily material type that influences percentage of shatter, not reduction activity. However, they do not include angular shatter in this argument, which is the type I record in my analysis so their argument does not directly apply.

Amount of Dorsal Cortex

The collection samples were then analyzed for presence and/or percentage of dorsal cortex (defined as the outer surface of raw material that is different from scars and cultural breaks) (Root 2004:68). There are some flaws with this method because the amount of cortex does not always correlate to a specific activity. The type of tool being produced, objective piece size, knapper, and production technique can all affect the amount of cortex found on debitage (Andrefsky 2001:11). However, while not applicable to all collections, amount of cortex can give researchers a rough estimate concerning reduction stages. To determine amount of dorsal cortex, Andrefsky's (1998:106-109) model was used. Each flake was given a cortex number of 0, 1, 2, or 3: 0 = no dorsal cortex; 1 = less than fifty percent dorsal cortex; 2 = more than fifty percent dorsal cortex; 3 = complete dorsal cortex. In a few cases where the dorsal cortex was close to fifty percent, a dot grid was used to determine if 1 or 2 should be assigned to the flake.

Mass Analysis

In addition to recording percentage of shatter and amount of cortex, mass analysis was conducted. Mass analysis is sometimes an overused and misapplied method which has led to hasty, redundant and inaccurate interpretations (Andrefsky 2007:393, 399). There are, however, appropriate situations in which mass analysis can be helpful. While I use mass analysis to make some inferences about lithic techniques, reduction stages, and tool types, these are not my primary goal. The focus of mass analysis in my project is to identify broad, statistically significant size differences among anomalies across the site that would point to varying (not necessarily specific) use of space.

Mass analysis was conducted in two phases. First, the collections recovered and recorded in 2009 were sorted using size graded shaking screens. Some debitage analysts (Kalin 1981; Ahler 1989) use five screens sized (in inches) 1-, 1/2-, 1/4-, 1/8-, and 1/16-, which is the method I employed. The diagonal measurement of the screen openings are slightly different than the exact measure of 1 inch, 1/2inch etc. (Table 2). Because the size of shatter is not related to the reduction stage, only the debitage flakes were mass analyzed; shatter was not included. The 2009 debitage collections, which totals 2431 flakes, were placed in the largest (1 inch) screen and shaken for two minutes. All pieces smaller than the one inch screen were collected and shaken in the ½ inch screen for two minutes. This process continued through each successive screen. As the 2009 collections were size graded, fifteen percent of the sorted flakes were weighed. Each size category was given a mean-high and mean-low weight. For example, 0.1 grams to 0.4 grams were the confines of the 0.125 size category. A mean-high and mean-low weight were established for each size grade (Table 3).

The second phase of mass analysis concerned the collections recovered and recorded in 2008. These collections had previously been weighed. They were sorted in the Microsoft Access database into size categories based on the parameters set by the 2009 size categories determined from mean-high and mean-low weights

Research Question 1: Did stone tool production vary by feature function?

According to Wilmerding and Kay (2011:59) features with different functions yield different debitage collections with varying characteristics. Percentage of angular shatter, amount of dorsal cortex on flakes, and flake size were recorded for each feature collection. Feature function (where inferred by Nolan 2010) was then tied to the results. For example, cobble testing or early stage reduction (high percentage of shatter) and biface manufacture (high percentage of zero dorsal cortex) were associated with a possible structure feature. The results from this possible structure collection were statistically compared with results from other feature collections (storage pit, midden deposit, midden with dog remains etc.) to determine whether there was any correlation between lithic activities at one type of village feature and lithic activities at another type of village feature. The specific statistical tests used to conduct this analysis can be found in the statistical methods section.

Research Question 2: Do debitage attributes and debitage density vary geographically across the landscape?

To answer this question, debitage collections analyzed were not limited to feature samples. Instead, the sample included all debitage associated with an anomaly or trench. The idea is that this analysis will identify discrete pockets of certain activities or at least levels of activity across the site. In answering this question, it is not a goal to understand the exact reduction strategy employed at certain anomalies, although inferences are certainly made. Instead, methods which correlate to determining reduction strategy need only express a statistically significant difference (or lack of difference) between one or more anomalies/trench across the site.

Research Question 3: What do significant differences (or lack thereof) in debitage among features and across space imply about Reinhardt occupants?

Debitage is an artifact that preserves well and is generally deposited in close, if not exact, proximity to where it was produced (Root 2004:65). Therefore, interpreting the density, characteristics, and location of debitage is important to interpreting where and how it was originally produced or discarded. David Clarke (1977:9) stated that analysis of use of space was

"the retrieval of information from archaeological spatial relationships and the study of the spatial consequences of former hominid activity patterns within and between features and structures and their articulation within sites, site systems and their environments: the study of the flow and integration of activities within and between structures, sites and resources spaces…".

One tie among debitage, space, and social structure is the identification of specialization at a site. Cross (1990) produced a model for predicting the presence of specialization at a site. Some of the predictive signs are greater numbers of production steps, spatial separation of production stages, and uniformity in debitage.

Some archaeologists attest that specialization is usually attributed to state-level and, in this region, Mississippian societies. Reinhardt does not fall into either description. However, they also suggest that the presence of "logistical task groups" in less complex societies can be identified. The presence of these task groups indicates an economic inter-dependency within a group (Moore 2011; see also Nolan 2005; Nolan et al. 2007; Yerkes

2005). In my research, I use the results from answering the first two research questions to identify the presence of these task groups at Reinhardt and subsequently an interdependent economic system.

Statistical Methods

One of the issues that most negatively impacts previous debitage analyses in the MORV region is the lack of statistical tests used to support conclusions. If statistical tests were conducted in these studies, the researchers' failure to report the results of the tests is disconcerting and weakens their conclusions. To avoid this pitfall, all conclusions in my research are based on outcomes from statistical tests.

All statistical tests for my thesis were conducted using IBM SPSS Statistics 20. To test for difference in material proportions among collections, the Mann-Whitney U test was employed. The Mann-Whitney U test is a nonparametric test. To test for significant differences (or lack thereof) among feature debitage collections, and among anomaly/trench collections, the Kruskal-Wallis test was employed. The Kruskal-Wallis test is a formula for testing for differences between two or more independent groups (Kruskal and Wallis 1952). This test works best for my data because it can analyze both nominal and ratio variables. A parametric ANOVA test will only analyze multiple groups using variables which are ordinal, interval, or ratio. Because my multiple variables are mostly categorical (nominal), Kruskal-Wallis is the best fit. Statistical significance is set at $\alpha = 0.05$. Results from these statistical tests reveal which, if any, debitage collections share characteristics or density, and thereby imply if lithic activities varied by feature function or space.

CHAPTER IV: Results

In this chapter, I present the results and statistical summaries for debitage attributes that were analyzed to answer my three research questions: 1) Do inferred debitage activities vary by feature function? 2) Does debitage type and density vary geographically across the site? 3) What do significant differences (or lack thereof) in debitage among features and across space imply about Reinhardt occupants? To understand the collection as a whole, descriptive statistics were computed for the entire debitage sample. Then, the collections were broken into two meaningful samples. First, the collection was broken into samples relating to a specific feature in order to understand the relationship between feature functions and lithic activities. Second, the collection was divided into samples relating to each anomaly/trench in order to understand the relationship between space and lithic activities. This chapter is meant to provide context for the subsequent chapter which discusses the implications of the results.

Descriptive Results

Altogether, attributes of 4,203 flakes and angular shatter pieces were analyzed from ten anomalies/trench including nine features. Of the 4,203 artifacts, 3,607 were flakes and 596 were angular shatter specimens. Angular shatter constitutes 14 percent of the collection. Four known chert materials make up a 71 percent of the collection: Delaware, Brush Creek, Upper Mercer, and Flint Ridge. The other two material categories are "Unknown" and "Other." Delaware is the most abundant material in the collection with a quantity of 1,182 debitage pieces (28 percent). It is closely followed by "Unknown" which has a quantity of 1,172 (28 percent). Upper Mercer constitutes 20 percent (N = 848) and

Brush Creek constitutes 17 percent (N = 732). The least frequently used materials are Flint Ridge with 246 (6 percent) and "Other" with 23 (1 percent). The category "Other" consists of 9 Burlington chert flakes, 9 Wyandotte chert flakes, and 5 possible Attica chert flakes. Because each of these material categories consist of <10, I grouped them together in the category "Other." This helps control for skewing in statistical tests. This differs from "Unknown" which refers to materials that I found unidentifiable. The general artifact percentages and counts by material type are shown in Figure 6. The following statistical analyses were conducted in order to answer my three research questions using the before mentioned methods of recording counts, percentage of shatter, amount of dorsal cortex, and size.

Originally, all analyses for "percent of shatter" and "size" were to be conducted separately for each material type. This would control for errors created by debitage breaking differently because of material as opposed to technology or technique. Using the Mann-Whitney U Test, difference in material proportions were tested among collections. For example, F32/09 consisted of 14 percent shatter across all material types. The Mann-Whitney U Test was employed to test that 14 percent against the percent of shatter of Delaware material in F32/09. There was no significant difference between F32/09's overall percent of shatter. This was done for each feature/anomaly (Figure 7). From the results, I did not find it necessary to analyze "percent of shatter" separately for each material type.

A Kruskal-Wallis one way analysis of variance test showed there are two significant differences among material type and flake size. First, Flint Ridge is significantly smaller in size relative to every other material type. However, because Flint Ridge is significantly smaller than all materials, and because these materials are present in all features and anomalies, this difference does not affect comparisons.

Second, Upper Mercer and Unknown were significantly different in size according the Kruskal-Wallis Test. However, out of a possible 45 combinations of anomalies, only 4 were significantly different in percentages of Upper Mercer and Unknown. This means, that while the two materials are different in size, the percentages of that material type present in an anomaly sample is the same, limiting the impact of the material type/size difference.

One category does pose a problem to the validity of results. Upper Mercer and Delaware were significantly different in size. In addition, a majority of percentages of Upper Mercer and Delaware quantities among anomalies were significantly different. This may affect the results of size differences occurring from cultural impact as opposed to geological composition of raw material. However, because it is only one combination of raw materials that differ by size, it was decided that collections by feature/anomaly not be separated by raw material when analyzing "percent of shatter" and "size" This decision was made in the interest of time and for the ease of comprehension of results; however, future research may want to divide collections by raw material for more detailed results.

Research Question 1: Do inferred debitage activities vary by feature function?

In order to answer this question, only artifacts associated with features (not artifacts found in the plow zone, backfill, or surface) were analyzed with statistical tests. The one exception is A80. A80 has four associated features two of which are post molds. Almost all debitage collected from this anomaly were associated with F43/08 which was a probable rodent burrow. Because F43/08 is in such close proximity to the post molds, because analysis of debitage strictly from a rodent burrow would not be very meaningful, and because all features could be related to a structure, the entire collection was included for feature analysis. Doing this increases the chance of mixing primary and secondary deposits but that is outweighed by the importance of including a sample associated with a probable structure within the Hopewellian enclosure.

Collections from nine features (including A80) were analyzed. The F16/08 and F17/08 collections were combined under F16/08 because both were located in the same anomaly and were associated with the same function (trash pit). Therefore, eight samples were analyzed constituting collections from nine features. F8/08 was a trash pit similar in materials and size to F16/08. In the interest of time and to avoid redundancy, F8/08 (inside A6) was eliminated from this section of analysis. Also not included was A10 because there is no associated feature. The features analyzed are as follows: a limestone cluster/trash pit (F16/08, this includes F17/08), a trash pit filled with ash and burnt materials (likely from a hearth cleaning) (F20/09), an *in situ* burning (F26/09), a large trash pit with burials present (F32/09), an unknown function (F34/09), midden with intact dog remains (F6/08), a shallow trash pit (F9/08), and a structure (A80).

Quantity

From the eight feature samples, 2404 flakes and 408 angular shatter pieces were analyzed. The feature with burials exhibits the highest quantity of flakes (N = 686) and is 29percent of the entire sample. The shallow trash pit contains 18percent of all feature flakes (N = 425). The hearth feature consitutues14percent of flakes (N = 329). A80, associated with a possible structure, constitutes an additional 14percent of the feature collection (N = 326). Only 12percent of flakes were recovered from the midden with intact dog remains (N = 286), and only 10 percent of flakes came from the *in situ* burning episode (N = 236). The limestone cluster trash pit contained only 3percent of the sample (N = 71). Finally, the unknown feature exhibits the lowest quantity of flakes (N = 45) and is 2percent of the entire sample. All quantities and percentages are shown in Table 4 (percentages have been rounded up to the next whole number in this text). A visual representation of these numbers can be seen in Figure 8. These frequencies are for whole features and do not control for volume excavated.

Amount of Shatter

The next step was calculating percent of shatter in each feature (Figure 9). A80 exhibited the highest percentage of shatter with 26 percent. F16/08 exhibited the lowest percentage of shatter with only three percent and F6/08 contained only 5 percent of shatter. Samples from F20/09, F26/09, F32/09, F34/09, and F9/08 are all within three percentage points of each other (12% - 15%). Once percentages of shatter were calculated for each feature, the same analysis was conducted but with each collection being further divided by material type.

Although there was no significant difference among amount of shatter and material type, percentages were calculated for descriptive purposes. Brush Creek debitage (N=527) has a shatter percentage of 17 percent (Table 5). Upper Mercer debitage (N=509) also has a shatter percentage of 17 percent (Table 6). Unknown material debitage (N=721) has a shatter percentage of 15 percent (Table 7). Delaware debitage (N=872) has a shatter percentage of 12 percent (Table 8). Flint Ridge (N=179) has a shatter percentage of 10 percent (Table 9).

Amount of Dorsal Cortex

Angular shatter pieces were not analyzed for amount of cortex because cortex on shatter does not necessarily reflect cultural activities. Therefore, only flakes were used in this analysis. According to the Kruskal-Wallis test, there are no significant differences in amount of cortex among features with two exceptions. F9/08 (a trash deposit) and A80 (possible structure), and F16 (limestone cluster trash pits) and A80 (possible structure) (Table 10). All other comparisons between features and amount of cortex report at $p \geq 0.3$. A majority of the tests report a p value of 1.0 meaning they are nearly identical. Raw data for amount of cortex by features can be found in Table 11.

Flake Size

The final feature data to be statistically analyzed are size of flakes – angular shatter was not included. A Kruskal-Wallis test reveals seven significantly different relationships ($p \leq 0.05$) in size of debitage involving 6 distinct features. However, I included an eighth relationship (A80 – A6) because it is has a p value of 0.051 (Table 12). Five of the eight significant relationships involve A80, the only feature associated with a possible structure from an area determined to predate the rest of the site. F32/09, F20/09, F26/09, F34/09, and F6/08 have significantly different debitage size collections from A80. A80 differs from the five features because it exhibits either significantly more "small" debitage (size categories .125 and .25) or because it contains significantly less "large" debitage (size category .5). The other three statistically significant differences involve F9/08, a large oval stain that has an unknown function. F32/09, F20/09, and F26/09 all exhibit significantly less "small" debitage (size categories .125 and .25) or significantly more "large" debitage (size category .5) than F9/08.

Research Question 2: Does debitage type and density vary geographically across the site?

To answer this question, the entire collection from nine anomalies and one trench was analyzed. The quantity, percentage of shatter, amount of cortex, and size were analyzed for each anomaly/trench and then compared for significant differences (or lack thereof). In total, 3607 flakes and 596 pieces of shatter were analyzed in this section.

Geographic Quantity

Curiously, debitage quantities within anomalies are, for the most part, grouped together (Figure 10). As mentioned earlier, anomaly counts do not include surface finds. In my thesis, anomalies refer to all debitage from features combined (Table 1) and debitage from subsurface fill not associated with particular feature. Debitage is most abundant in the western portion of the site. Trench 1 (referring to one $4m^2$ unit inside the trench; see *Literature Review*) and Anomaly 47 account for the highest debitage counts. Individually, they have more than 750 debitage pieces. The second greatest quantity is clustered in the southwestern area -- between 400 and 500 pieces represented by A69 and A19. The one outlier in this quantity category is A80, located at the northern section of the excavated site. A10, A77, and A132 are located in the eastern section of the site and have debitage counts between 250 and 350. The only quantity category not located in an identifiable cluster consists of counts totaling less than 200, represented by A6 and A124. These are located on the western half of the site but are interrupted by A19 (Figure 10).

Amount of Shatter

The quantity of flakes and the percentage of angular shatter were tabulated for each anomaly/trench (Figure 11). The anomaly with the highest percentage of shatter was A80 with 26 percent closely followed by A124 with 23 percent. It is interesting to note that A6 exhibited no shatter. The anomaly with the lowest percentage of shatter (where present) was A132 with 4 percent.

Amount of Dorsal Cortex

With the inclusion of all debitage pieces (not just those associated with features) there is a marked increase in significant differences among samples. The Kruskal-Wallis test identified a significant difference ($p \leq 0.05$) among eight anomalies/trench. One additional pair, with a $p = 0.053$, is worthy of discussion. Of the nine pairs, those most often repeated are four associated with A69 located on the southwestern edge of the site, four associated with A6 located on the western side of the site, and three associated with A77 located in the southeastern region of the site. The significant differences are listed in Table 13.

Flake Size

The final statistical test run was for size grade among anomalies/trench. This comparison (size of debitage flakes among anomalies/trench) produced the highest number of statistical differences of any tests conducted. There are significant differences between thirteen pairs of anomalies/trench (Table 14). Those which are most repeatedly different are A10 located in the center of the site and A80 which is located inside the confines of the Peter's Square Ditch at the northeastern edge of the site.

Summary

The above results from macroscopic analysis and statistical tests identify differences (or lack thereof) among anomalies and feature functions. When debitage was analyzed for percent of shatter, few differences occurred among features or anomalies. Significant differences were also rare in amount of cortex, especially among features. The majority of significant differences were found in size among both anomalies and features.

Research Question 1: Do inferred debitage activities vary by feature function?

Among features, there are only two significant differences in percent of shatter. Both instances involve A80, the feature inside Peter's Square (Figure 5). All difference in amount of cortex occurred only in connection with A80, located inside Peter's Square ditch feature. Five of the seven size differences are associated with A80.

Research Question 2: Does debitage type and density vary geographically across the site?

Although an excavation and volume bias exist for quantity of debitage across the site, a preliminary analysis tends to find counts grouped together across the site in general zones (Figure 10). A47 and T1 are in the Red Zone and have counts greater than 750. A69 and A19 are in the Blue Zone and have counts between 400 and 500. A10, A77, and A132 are in the Green Zone and have counts between 250 and 350. A12 and A6 have counts less than 200, however, they are not located in the same area. A80 is an outlier. It has between 400-500 pieces which would associate it with A69 and A19 (Blue Zone) but it is not located near them.

Among anomalies, percent of shatter includes four distinct anomalies which, when lines are drawn to connect the significant differences, create a ring in the village. Amount of cortex differences among anomalies are more prevalent than among features and, interestingly, all nine differences are connected with at least one of the following: A6, A69, and A7. Finally, eleven of the thirteen significant size differences involved either A10 (at the center of the site) or A80 at the most northern edge.

CHAPTER IV: Discussion

In this chapter, I build upon the numbers and statistics reported in the previous chapter to answer each of my three research questions.

Research Question 1: Did debitage activities (late stage reduction, early stage reduction, etc.) vary by feature function (hearth, structure, midden, etc.)?

As previously noted, results indicate that variations in lithic production/reduction techniques by Reinhardt occupants correlate to designated activity zones.

Percentage of Shatter

At Reinhardt, percentages of shatter do not vary among features with a couple exceptions (Figure 12). Over ¼ (26 percent) of the feature within Peter's Square (A80) debitage collection consists of shatter. This sample stands alone. The technology or industry employed within the confines of the Peter's Square Ditch significantly differ from the trash pit with dog remains (F6; 3 percent shatter) and limestone trash pit (F16; 5 percent shatter). It would appear that activities at A80 likely included core reduction or early stage percussion as these generate high amounts of shatter; however, this is not supported by data from the aggregate size analysis (see below). In general, core reduction yields significantly higher percentages of shatter than other activities like the manufacture of scrapers (Baumler and Davis 2004:58; Root 2004:73; Sullivan and Rozen 1985:758-759). Based solely on percentage of shatter, activities at the trash deposit with dog remains and limestone trash pit indicate later stage reduction or sharpening/refining of tools. While this is supported by relatively high percentages of small flakes (see below) it is contradicted by relatively high percentages of large flakes.

All other percentages of shatter from features are not significantly different from each other or from A80, F6/08, and F16/08. F20/09 (14 percent), F26/09 (15 percent), F32/09 (14 percent), F34/09 (12 percent), and F9/08 (12 percent) are separated by 3 percentage points at most. Because the differences among the five features are not statistically significant ($x^2 = 6.45$; $p = 0.168$) it is possible they shared core reduction techniques. Lithic manufacturing at these features likely included core reduction and cobble testing but these activities were more prevalent at A80.

Amount of Cortex

There are two sets of significant differences among amount of cortex at features: F9/08 flakes and A80 flakes ($w = -137.012$; $p = 0.021$) and F16/08 flakes and A80 flakes ($w = -225.620$; $p = 0.049$). F9/08 and F16/08 exhibit the highest percentages of flakes with no cortex (category “0”). A80 exhibits the lowest percentage of flakes with no cortex. Outside Peter’s Square Ditch, there are no significant differences in amount of cortex (Figure 13). This indicates that the process for removing cortex was standard throughout the village no matter the knapper, technique or activity. A standardization of raw material preparation or at least a standard procedure in removal of cortex from the objective piece was likely followed at Reinhardt and is distinct from the procedures associated with the earlier occupations of the area.

Size Grade

A majority of the collections exhibit high quantities within two size categories: 0.25 and 0.125 which is neither surprising nor very telling. The archaeological excavation method employed at Reinhardt, as with most other sites, used primarily ¼ inch screens which, though appropriate, creates a bias (Graesch 2009:760). Naturally, size categories smaller than ¼ inch were generally lost during screening. However, the following instances where quantities are unusually high in size categories .5 or .0625 are unexpected and worth analysis.

F6 (1.7 percent) and F16 (2.8 percent) exhibit relatively high percentages of .0625 but they are not significantly higher than the other features. There are eight significant pair differences involving seven distinct features (Figure 14). A majority of these differences (N = 5) once again point back to the possible structure inside Peter's Square, A80.

Research Question 2: Does debitage type and density vary geographically across the site?

As mentioned in the methods chapter, to address this question debitage from anomalies (including feature fill and general finds) were used to determine patterns geographically instead of by feature function. In order to better see the patterns, only differences are shown in the related figures.

Location/Quantity

As with feature analysis, there is a bias in debitage quantity based upon excavation methods. Across the village, debitage is clustered together by quantity with the exception of A80 (blue; N = 400-500), and the lowest counts, A6 and A124 (orange, N < 200) (Figure 16).

Cook (2008) is able to divide the SunWatch site into four zones based upon counts of artifacts. At Reinhardt, the density of debitage also appears to be in clusters. When lines are added to divide similar debitage quantities, similar to what Cook (2008) did in his research, the density of debitage appears to cordon the site into distinct clusters (Figure 10). The clusters are interrupted by anomalies with less than 200 debitage pieces, and by the possible structure within the confines of the Peter's Square Ditch.

The four areas identified by Cook (2008) were not defined by artifact density alone. Nor were they demarcated to merely illustrate the highest concentration of activities. Rather, they are part of a broader, more complex analysis that asserts the site was designated into four distinct household groups. Using only debitage and a limited sample of features/anomalies, it is not possible to conclude Reinhardt exhibits this circumferential patterning. However, debitage density groups do support this idea (though biased by volume excavated at each anomaly). Future analysis which includes a larger sample of anomalies/features and additional artifact types (ceramics, stone tools, organics, etc.) will help determine whether household groups may have been present at the Reinhardt site.

Percentage of Shatter

A80 and A124 have the highest percentages of shatter with 26 percent and 23 percent, respectively. Unique to the entire collection is A6 which contains no pieces of shatter. A132 had the second lowest percentage of shatter with 4 percent. A80 and A124 significantly differ from A6 and A132 (Figure 17). All other anomalies are separated by 5 percent, at most (A77:14 percent; A10:14 percent; A19: N15 percent; A69: 12 percent; Trench 1:10 percent; and A47: N14%). Interestingly, the difference between A80 and A132 is also reflected in the associated feature analysis (see above) where A80 differs from F6/08 (which is contained in A132).

Amount of Cortex

Unlike analysis among features, cortex varies geographically across the site. There are thirteen pairs that are statistically different (Figure 18). We don't see the standardization of cortex removal among anomalies that is exhibited in features.

Size Grade

Nolan (2010) identified rings of activity surrounding a possible plaza at Reinhardt (Figure 20). Anomalies (including the ones used in my research) contributed to Nolan's interpretation. Among anomalies in my sample, size is the most frequent difference. A majority of size differences point back to A80 and A10 (Figure 19). Interestingly, other differences travel in a concentric pattern, around where the probable plaza would have been located as opposed to across the plaza. This is consistent with Nolan's (2010) interpretation of circular rings within the village (Figure 20).

Research Question 3: What do significant differences (or lack thereof) in debitage among features and across space imply about village layout?

Feature Conclusions

A lack of significant differences in debitage across a site is indicative of standardized manufacturing practices. The standardized debitage collections support that Reinhardt occupants did not practice craft specialization. Moore (2011) notes that craft specialization is tied to Mississippian societies which further excludes the Reinhardt site. However, he also suggests that in less complex societies (like Reinhardt) there can be a presence of "logistical task groups." One line of evidence for these task groups includes uniformity in debitage (Moore 2011:159). Similar percentages in shatter among most features and the presence of a uniform trait (lack of cortex on debitage) across the site presents a case for some form of standardization.

In complex prehistoric villages or cities (e.g., Moundville and Cahokia) debitage is fairly similar when relating to specific feature functions. Percentage of shatter and amount of cortex support that pattern at Reinhardt; however, size of debitage contradicts the assumption. This indicates that prior to the manufacture of stone tools, Reinhardt occupants had a standard method of preparing cores and cobbles, and starting the reduction process. The only outlier is A80.

A80 is the sample included in this analysis that likely predates the rest of the site. . Whether because of its function (dwelling, community building, etc.) or because it predates the other feature samples, significantly different lithic activities were conducted here. As seen in Figure 15, most differences (shatter, cortex, and size) point back to A80, inside the Peter's Square Ditch.

Geographic (Anomaly) Conclusions

There are many significant differences among anomalies. What are most interesting are the patterns in which these differences appear. A majority of differences in shatter (though few), amount of cortex, and especially size, seem to circle the site rather than cross it. The exception is A80. While A80 does not appear to be an outlier in amount of cortex, most differences point back to A80 in size grade. All significant differences can be seen in Figure 21.

Reinhardt occupants had ideas about space that were integrated into lithic activities. Among features, debitage does exhibit some significant differences although a majority of these are related to A80. Among anomalies, circular patterns are seen and specific areas are highlighted by significant differences. Whether applied to how debitage was prepared, created, or disposed, there are certainly marked differences depending upon feature function and/or geographic location; i.e., where it was acceptable or unacceptable to conduct certain lithic activities. In turn, similarities among percent of shatter and amount of cortex indicate that there were also standardized methods of preparing and beginning tool production. Most interesting is that, even if we did not know its function, location, or temporal association, the raw data from my analysis would showcase A80 as distinctly different from the rest of the site.

My research serves as a stepping stone for future studies both at Late Prehistoric villages in the MORV and specifically at the Reinhardt site. With inclusion of other artifact types, larger samples, and additional research methods, a more refined understanding of how Reinhardt occupants viewed and used their village space can be achieved.

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Figures and Tables

Figure 1: Pickaway County, Ohio

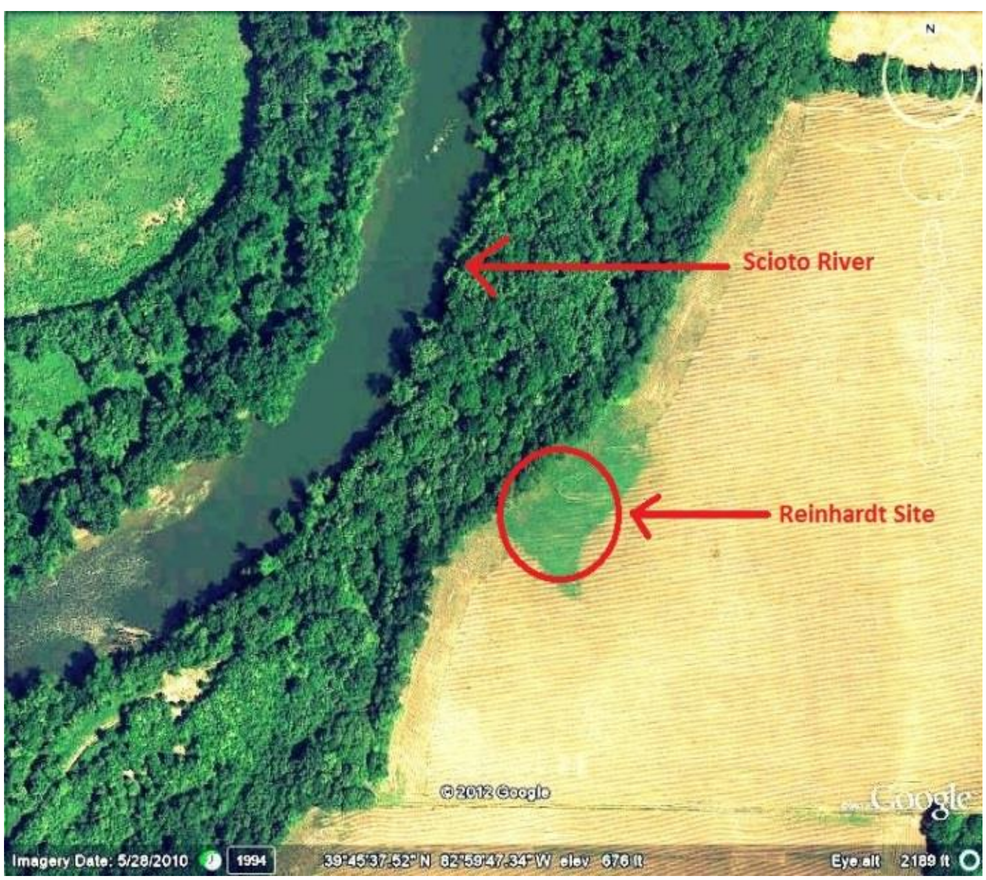


Figure 2: Location of Reinhardt on the Scioto River

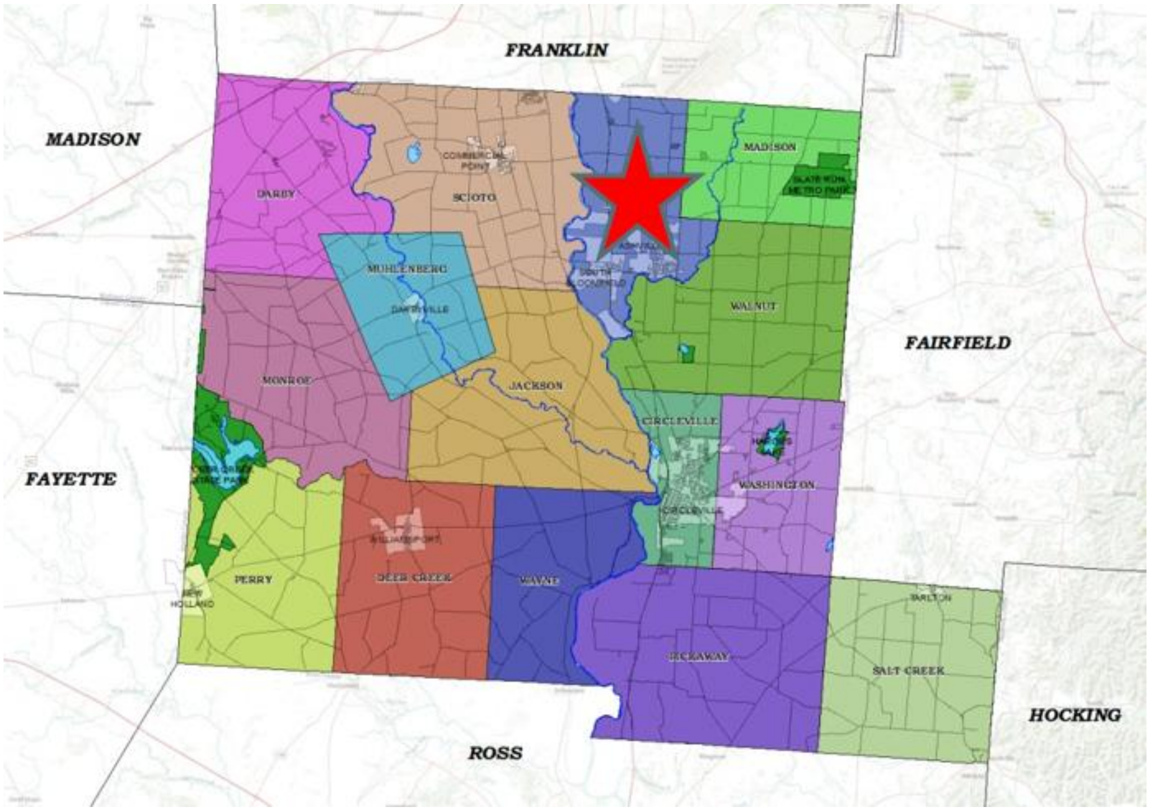


Figure 3: Harrison Township

Trench1	A6	A132	A77	A19	A124	A80	A10	A47	A69
F9/08 F12/08	F8/08	F6/08 F7/08 F14/08	F16/08 F17/08 FX/08	F20/09 F21/09 F22/09 F23/09 F24/09	F34/09	F43/09 F44/09 F45/09 F46/09	n/a	F31/09 F32/09 F33/09	F26/09

Table 1: Trench/anomalies and associated features. Those listed in red are used for the feature analysis.

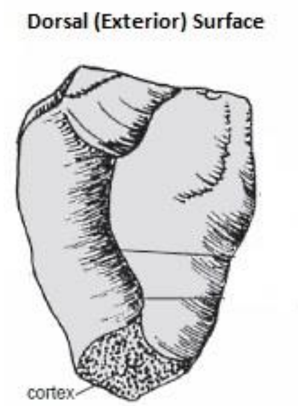


Figure 4: Example of cortex on the dorsal surface of a flake (adapted from Brandt 2013).

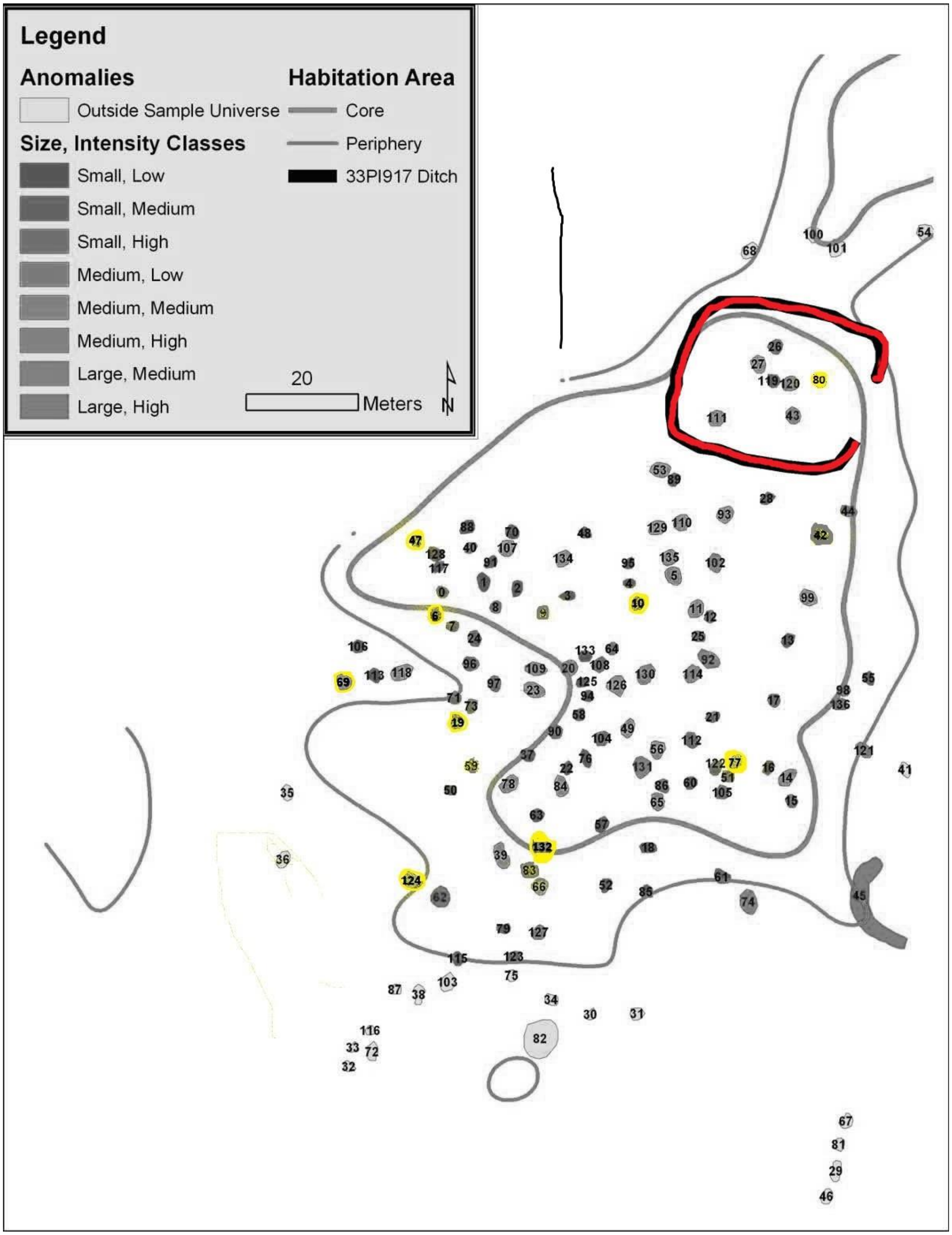


Figure 5: Highlighted features show preliminary selection of feature samples. Adapted from Nolan 2010:

Size Grade	Nominal Designation	Actual Square Opening Size *Inches*	*Millimeters*	Actual Diagonal Opening Size *Inches*	*Millimeters*
Grade 1	1 inch	.942	23.92	1.33	33.78
Grade 2	1/2 inch	.47	11.92	.597	15.16
Grade 3	1/4 inch	.223	5.67	.298	7.57
Grade 4	1/8 inch	.122	3.08	.153	3.89
Grade 5	1/16 inch	.066	1.69	.068	1.74

Table 2: Size grade designations and actual screen opening sizes (Ahler 1989:100)

Grade 1 (.0625)	Grade 2 (.125)	Grade 3 (.25)	Grade 4 (.5)	Grade 5 (1)
< .1	.1 - .4	.41 - .9	.91 – 10	> 10

Table 3: Size Class Categories by Weight (weights in grams)

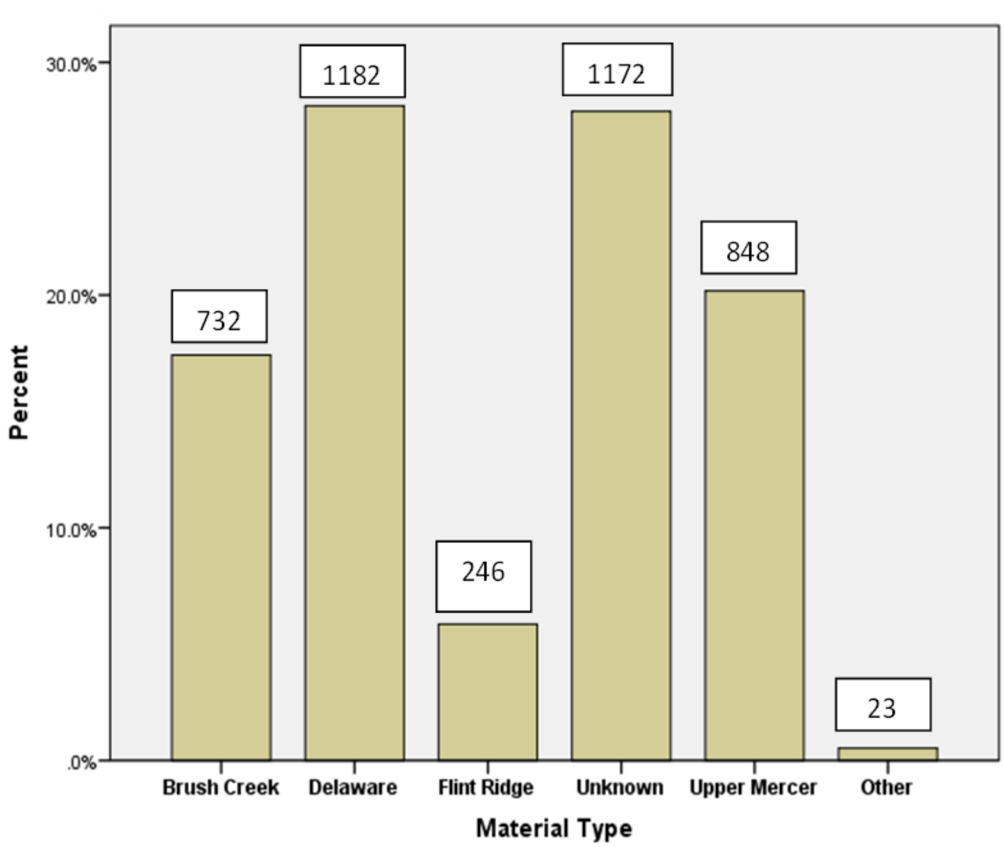
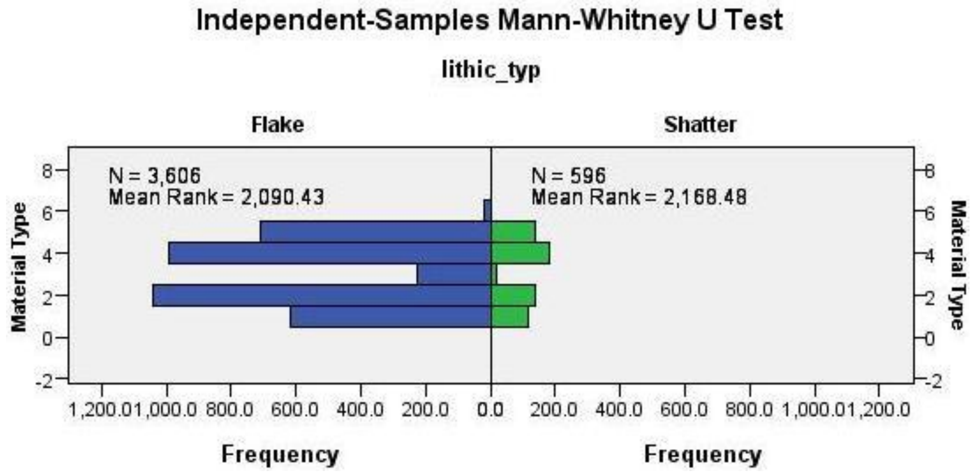


Figure 6: Debitage percentages and counts by material type



Total N	4,202
Mann-Whitney U	1,114,510.000
Wilcoxon W	1,292,416.000
Test Statistic	1,114,510.000
Standard Error	26,633.513
Standardized Test Statistic	1.499
Asymptotic Sig. (2-sided test)	.134

Figure 7 Mann-Whitney U Test. Impact of material type on percent of shatter

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F16/08	71	3.0	3.0	3.0
	F20/09	329	13.7	13.7	16.6
	F26/09	236	9.8	9.8	26.5
	F32/09	686	28.5	28.5	55.0
	F34/09	45	1.9	1.9	56.9
	F6/08	286	11.9	11.9	68.8
	F9/08	425	17.7	17.7	86.4
	A80	326	13.6	13.6	100.0
	Total	2404	100.0	100.0	

Table 4: Debitage percentages and counts by feature

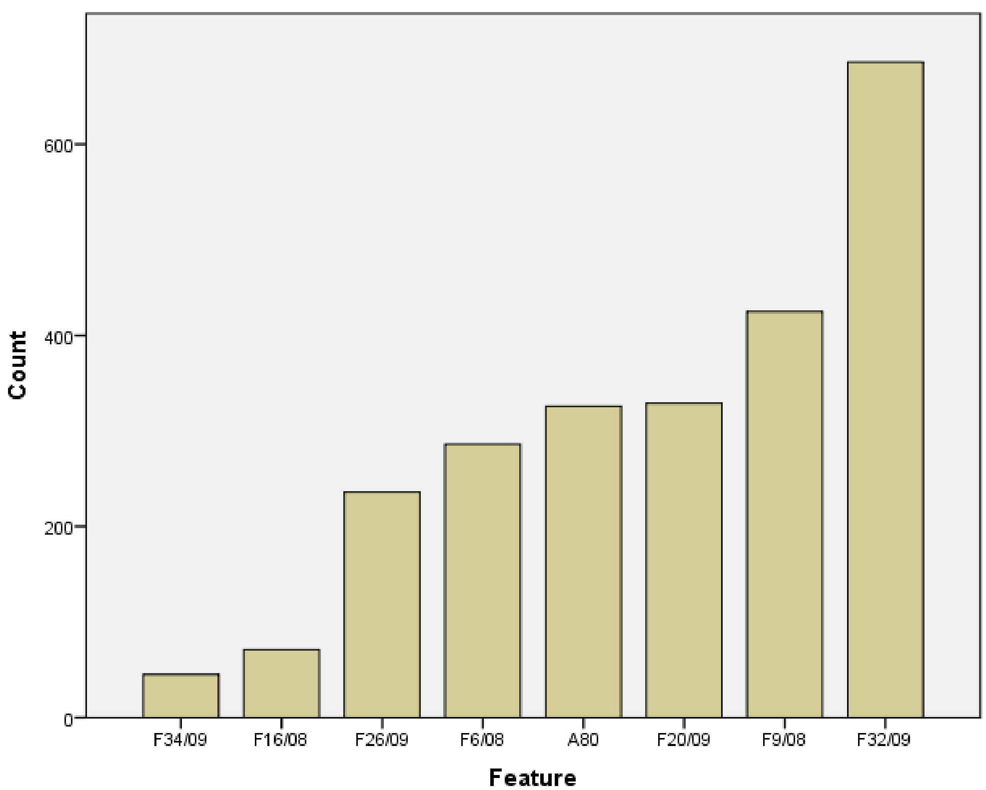


Figure 8: Percent of shatter by feature

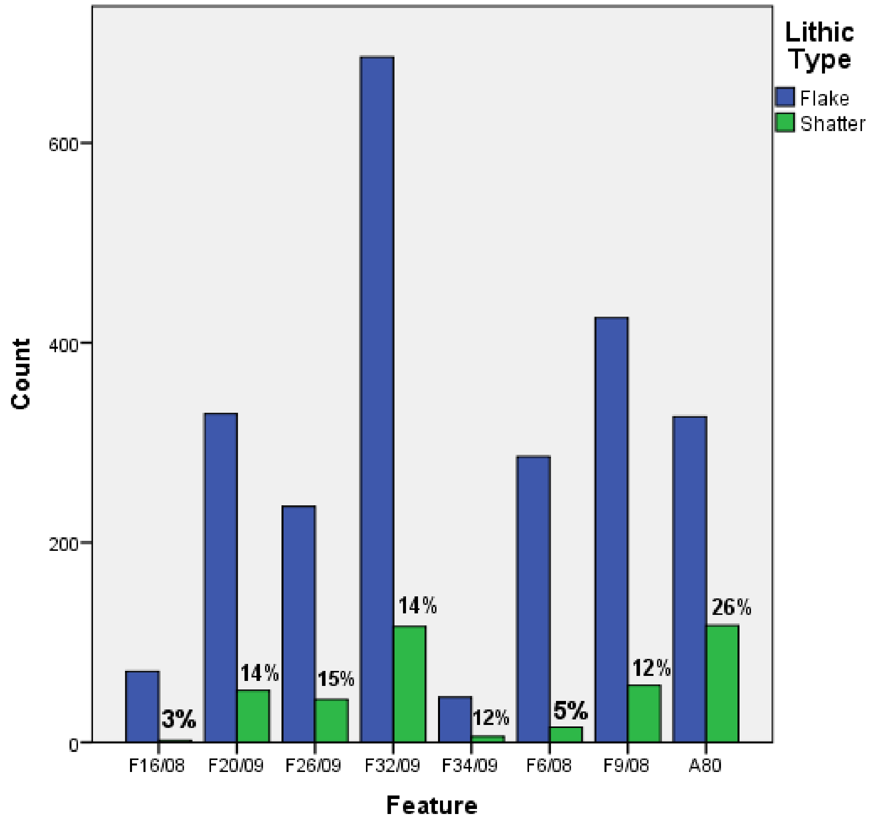


Figure 9: Debitage counts by feature

			Lithic Type		Total
			Flake	Shatter	
Feature	F16/08	Count	26	1	27
		% within Feature	96.3%	3.7%	100.0%
	F20/09	Count	46	13	59
		% within Feature	78.0%	22.0%	100.0%
	F26/09	Count	39	6	45
		% within Feature	86.7%	13.3%	100.0%
	F32/09	Count	177	26	203
		% within Feature	87.2%	12.8%	100.0%
	F34/09	Count	5	3	8
		% within Feature	62.5%	37.5%	100.0%
	F6/08	Count	94	6	100
		% within Feature	94.0%	6.0%	100.0%
	F9/08	Count	165	29	194
		% within Feature	85.1%	14.9%	100.0%
	A80	Count	58	27	85
		% within Feature	68.2%	31.8%	100.0%
Total		Count	610	111	721
		% within Feature	84.6%	15.4%	100.0%

Table 5: Percent of Brush Creek shatter by feature

Count/Percentage of Shatter – Upper Mercer Material

			Lithic Type		Total
			Flake	Shatter	
Feature	F16/08	Count	16	1	17
		% within Feature	94.1%	5.9%	100.0%
	F20/09	Count	33	11	44
		% within Feature	75.0%	25.0%	100.0%
	F26/09	Count	33	10	43
		% within Feature	76.7%	23.3%	100.0%
	F32/09	Count	89	21	110
		% within Feature	80.9%	19.1%	100.0%
	F34/09	Count	2	0	2
		% within Feature	100.0%	0.0%	100.0%
	F6/08	Count	112	6	118
		% within Feature	94.9%	5.1%	100.0%
	F9/08	Count	89	18	107
		% within Feature	83.2%	16.8%	100.0%
	A80	Count	49	19	68
		% within Feature	72.1%	27.9%	100.0%
Total		Count	423	86	509
		% within Feature	83.1%	16.9%	100.0%

Table 6: Percent of Upper Mercer shatter by feature

Count/Percentage of Shatter – Brush Creek Chert

			Lithic Type		Total
			Flake	Shatter	
Feature	F16/08	Count	7_{a}	0_{a}	7
		% within Feature	100.0%	0.0%	100.0%
	F20/09	Count	88_{a}	16_{a}	104
		% within Feature	84.6%	15.4%	100.0%
	F26/09	Count	52_{a}	11_{a}	63
		% within Feature	82.5%	17.5%	100.0%
	F32/09	Count	123_{a}	27_{a}	150
		% within Feature	82.0%	18.0%	100.0%
	F34/09	Count	11_{a}	1_{a}	12
		% within Feature	91.7%	8.3%	100.0%
	F6/08	Count	38_{a}	0_{b}	38
		% within Feature	100.0%	0.0%	100.0%
	F9/08	Count	27_{a}	2_{a}	29
		% within Feature	93.1%	6.9%	100.0%
	A80	Count	92_{a}	32_{b}	124
		% within Feature	74.2%	25.8%	100.0%
Total		Count	438	89	527
		% within Feature	83.1%	16.9%	100.0%

Table 7: Percent of Brush Creek shatter by feature

Count/Percentage of Shatter – Delaware Chert

			Lithic Type		Total
			Flake	Shatter	
Feature	F16/08	Count	11	0	11
		% within Feature	100.0%	0.0%	100.0%
	F20/09	Count	143	9	152
		% within Feature	94.1%	5.9%	100.0%
	F26/09	Count	98	14	112
		% within Feature	87.5%	12.5%	100.0%
	F32/09	Count	245	36	281
		% within Feature	87.2%	12.8%	100.0%
	F34/09	Count	25	1	26
		% within Feature	96.2%	3.8%	100.0%
	F6/08	Count	32	3	35
		% within Feature	91.4%	8.6%	100.0%
	F9/08	Count	123	8	131
		% within Feature	93.9%	6.1%	100.0%
	A80	Count	91	33	124
		% within Feature	73.4%	26.6%	100.0%
Total		Count	768	104	872
		% within Feature	88.1%	11.9%	100.0%

Table 8: Percent of Delaware shatter by feature

Count/Percentage of Shatter – Flint Ridge Chert

			Lithic Type		Total
			Flake	Shatter	
Feature	F16/08	Count	11	0	11
		% within Feature	100.0%	0.0%	100.0%
	F20/09	Count	19	3	22
		% within Feature	86.4%	13.6%	100.0%
	F26/09	Count	14	2	16
		% within Feature	87.5%	12.5%	100.0%
	F32/09	Count	50	6	56
		% within Feature	89.3%	10.7%	100.0%
	F34/09	Count	2	1	3
		% within Feature	66.7%	33.3%	100.0%
	F6/08	Count	8	0	8
		% within Feature	100.0%	0.0%	100.0%
	F9/08	Count	21	0	21
		% within Feature	100.0%	0.0%	100.0%
	A80	Count	36	6	42
		% within Feature	85.7%	14.3%	100.0%
Total		Count	161	18	179
		% within Feature	89.9%	10.1%	100.0%

Table 9: Percent of Flint Ridge shatter by feature

Each node shows the sample average rank of Feature.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
F9/08-A80	-137.012	40.702	-3.366	.001	.021
F16/08-A80	-225.620	72.141	-3.127	.002	.049

Table 10: Significant differences in cortex among features

Feature * Cortex Crosstabulation

Count

		Cortex				Total
		0	1	2	3	
Feature	F16/08	58	12	0	1	71
	F20/09	237	49	28	13	327
	F26/09	157	48	19	12	236
	F32/09	472	133	51	30	686
	F34/09	29	14	1	1	45
	F6/08	213	46	15	8	284
	F9/08	318	58	25	17	418
	A80	213	56	40	17	326
Total		1697	416	179	99	2393

Table 11: Raw data for amount of cortex by feature

Each node shows the sample average rank of Feature.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
A80-F32/09	202.433	42.778	4.732	.000	.000
F9/08-F32/09	169.248	39.259	4.311	.000	.000
A80-F20/09	201.210	49.672	4.051	.000	.001
A80-F26/09	202.485	54.325	3.727	.000	.005
F9/08-F20/09	168.026	46.676	3.600	.000	.009
F9/08-F26/09	169.301	51.600	3.281	.001	.029
A80-F34/09	323.372	101.081	3.199	.001	.039
A80-F6/08	160.755	51.593	3.116	.002	.051

Table 12: Differences in flake size among features

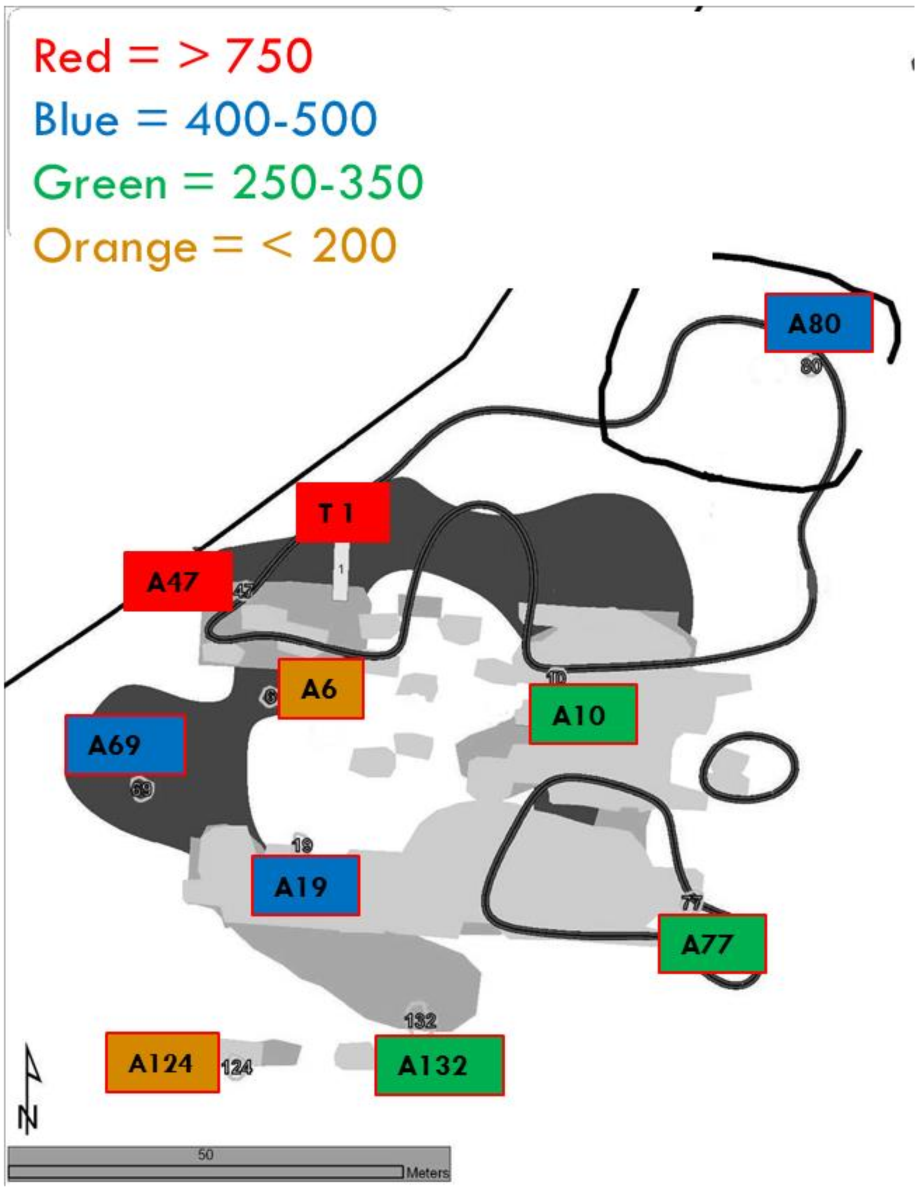


Figure from Nolan 2010. Edited from Original

Figure 10: Quantity Clusters

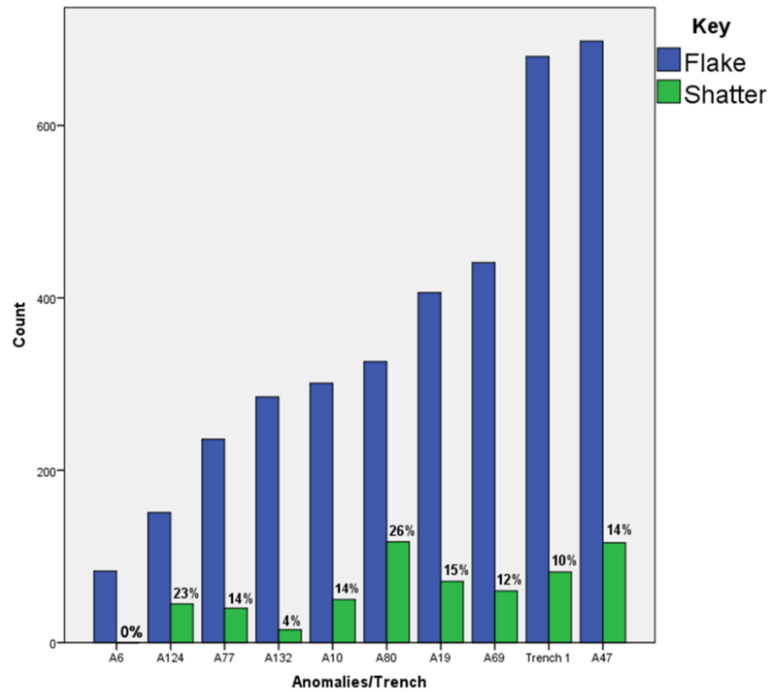


Figure 11: Percentages of shatter by anomaly

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
A77-A69	291.554	68.338	4.266	.000	.001
A132-A69	-261.286	64.467	-4.053	.000	.002
A77-A6	428.907	108.129	3.967	.000	.003
Trench 1-A69	198.714	51.805	3.836	.000	.006
A132-A6	-398.638	105.725	-3.771	.000	.007
Trench 1-A6	336.067	98.517	3.411	.001	.029
A77-A80	-244.856	72.418	-3.381	.001	.032
A19-A69	-193.900	58.278	-3.327	.001	.039
A19-A6	-331.253	102.070	-3.245	.001	.053

Table 13: Differences in amount of cortex among anomalies

Each node shows the sample average rank of Anomaly.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
A132-A10	363.306	79.824	4.551	.000	.000
A80-A10	602.691	77.203	7.807	.000	.000
Trench 1-A10	395.426	66.863	5.914	.000	.000
A47-A10	306.866	66.598	4.608	.000	.000
A80-A69	405.012	70.544	5.741	.000	.000
A80-A47	295.826	64.790	4.566	.000	.000
A77-A10	497.778	83.973	5.928	.000	.000
A80-A19	301.219	71.825	4.194	.000	.001
A80-A6	499.166	118.742	4.204	.000	.001
A19-A10	301.473	73.461	4.104	.000	.002
A77-A69	300.098	77.895	3.853	.000	.005
A80-A124	363.416	95.072	3.823	.000	.006
Trench 1-A69	197.747	59.050	3.349	.001	.037

Table 14: Differences in size among anomalies

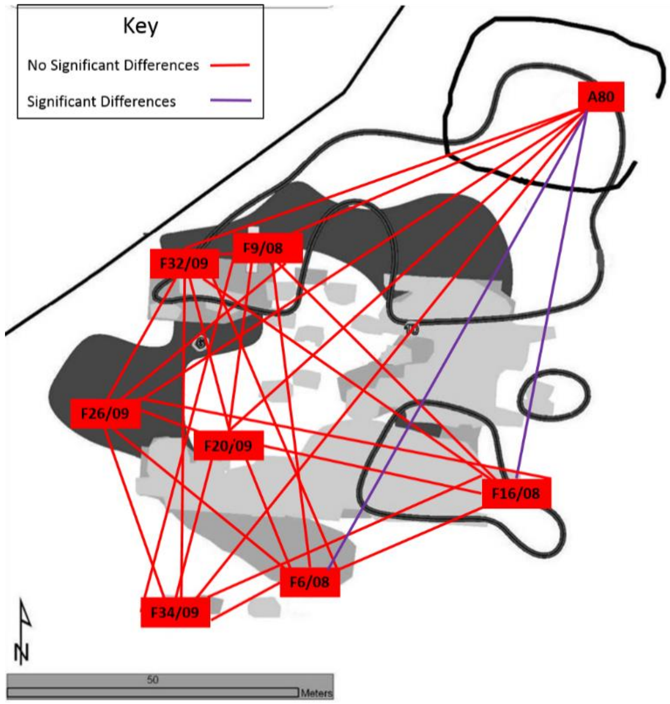


Figure 12: Percent of shatter across features: lines denote where similarities and differences occur

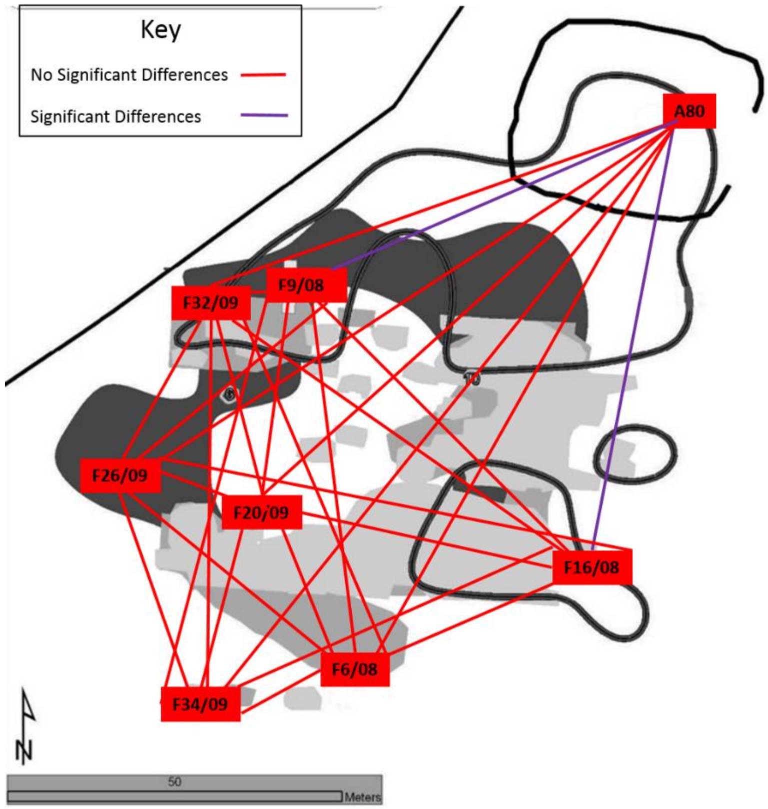


Figure 13: Amount of cortex: lines denote where similarities and differences occur

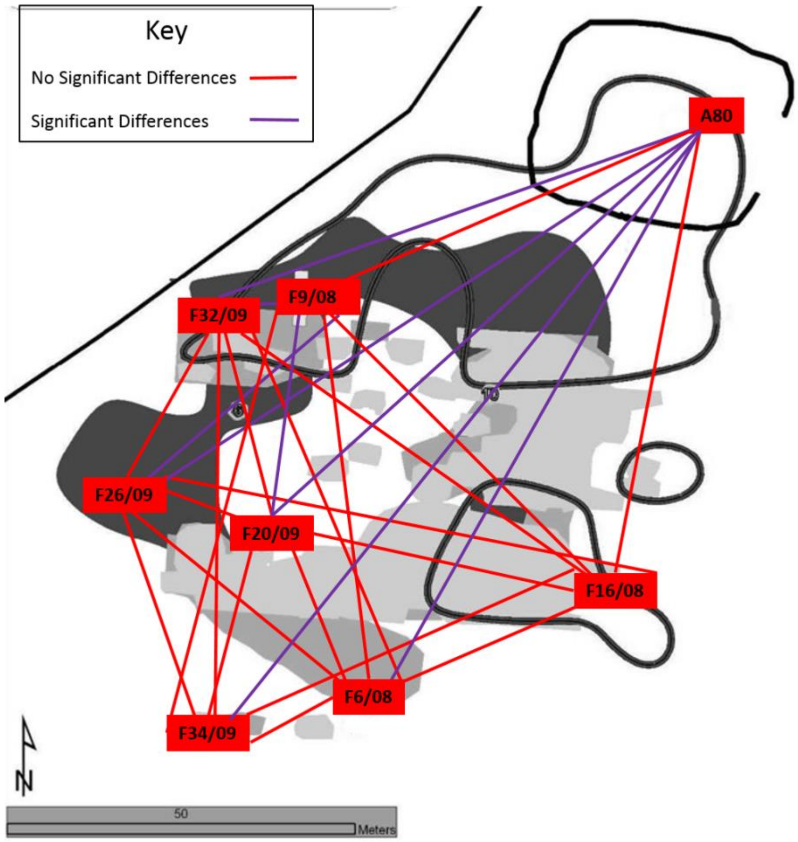


Figure 14: Size grade; lines denote where similarities and differences occur

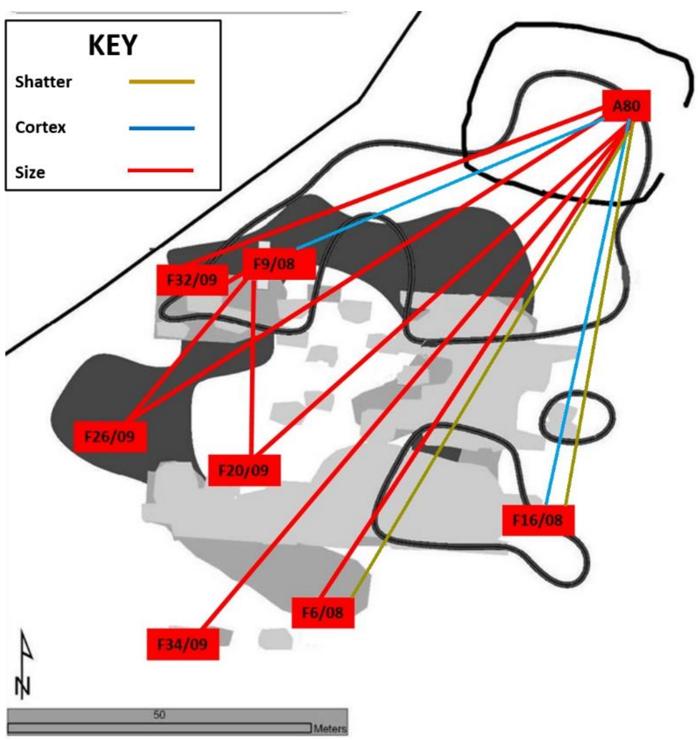


Figure 15: All differences among features: lines denote where differences occur

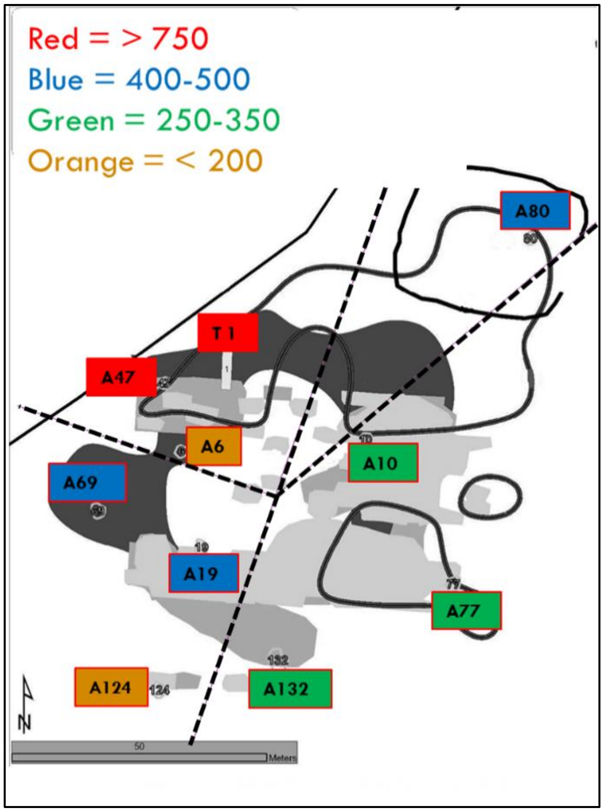


Figure 16: Quantity zones by debitage count

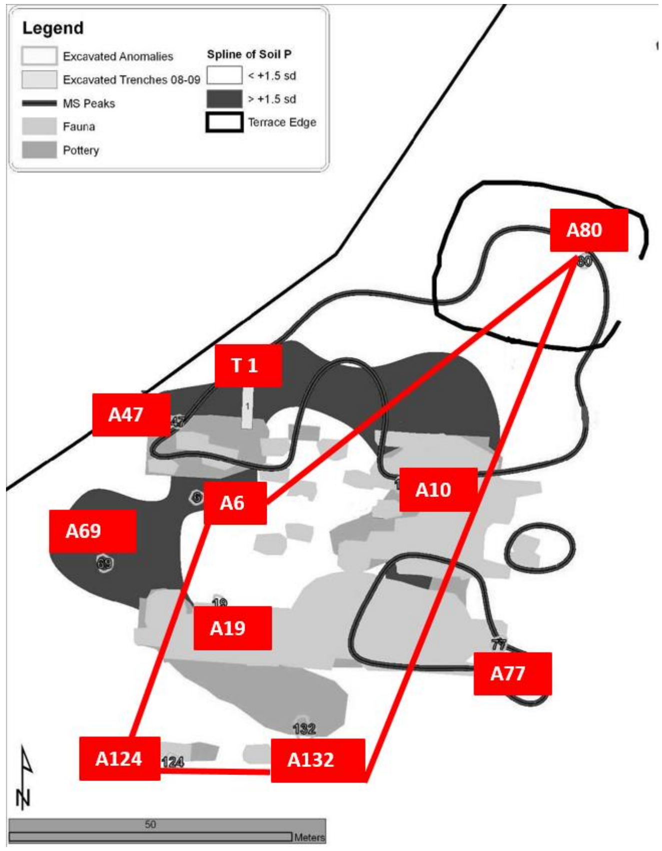


Figure 17: Percent of shatter; red lines denote where differences occur

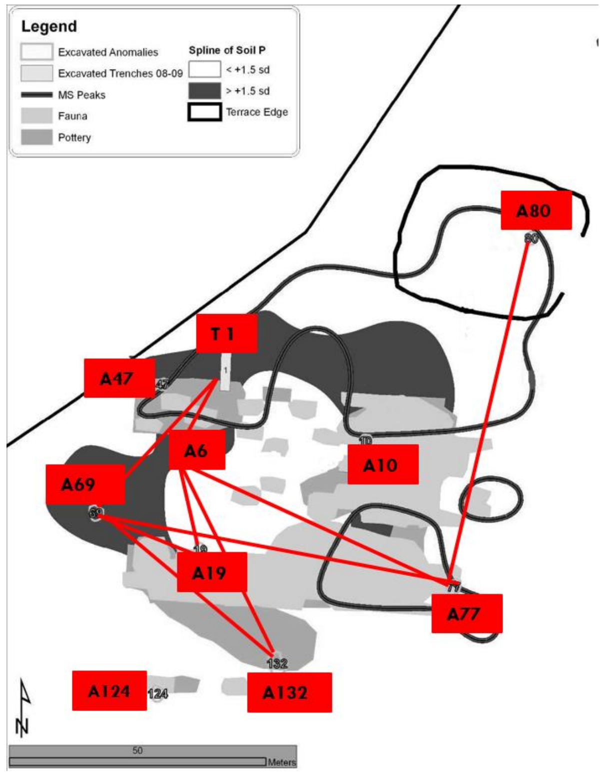


Figure 18: Amount of cortex; red lines denote where differences occur

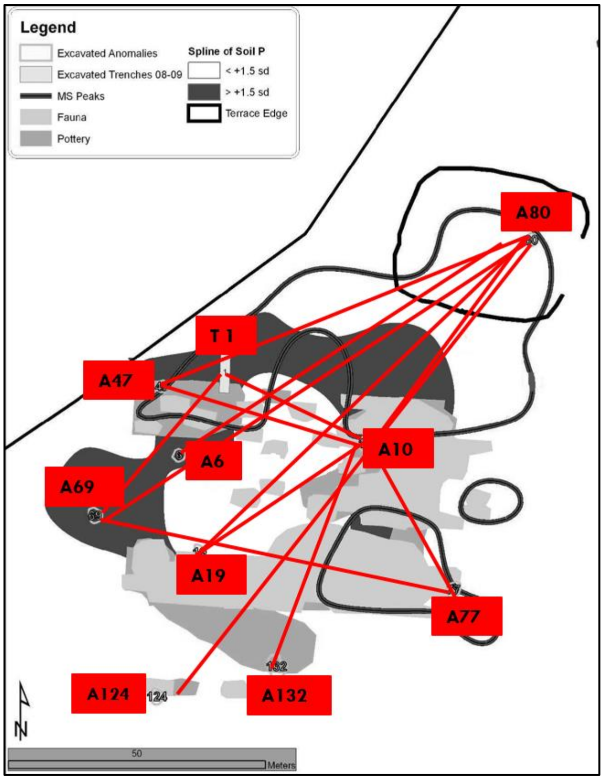


Figure 19: Size grade; red lines denote where differences occur

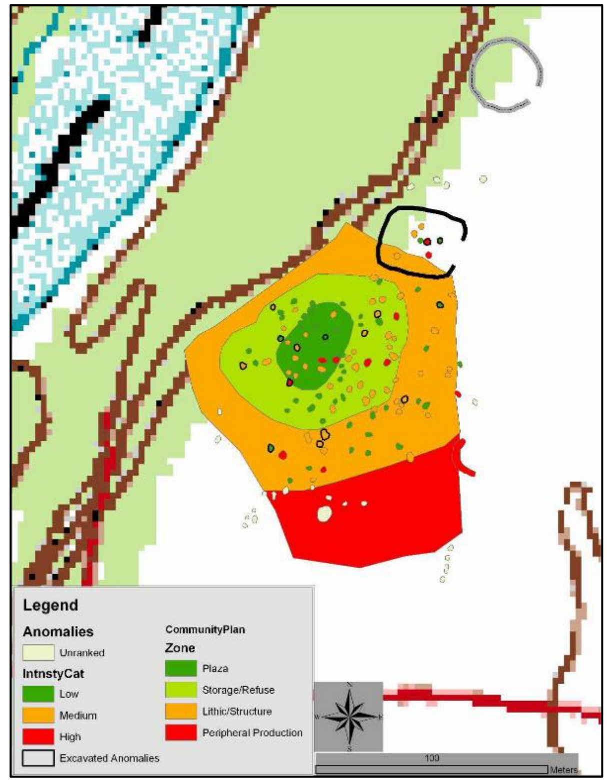


Figure 20: Density zones; Nolan 2010

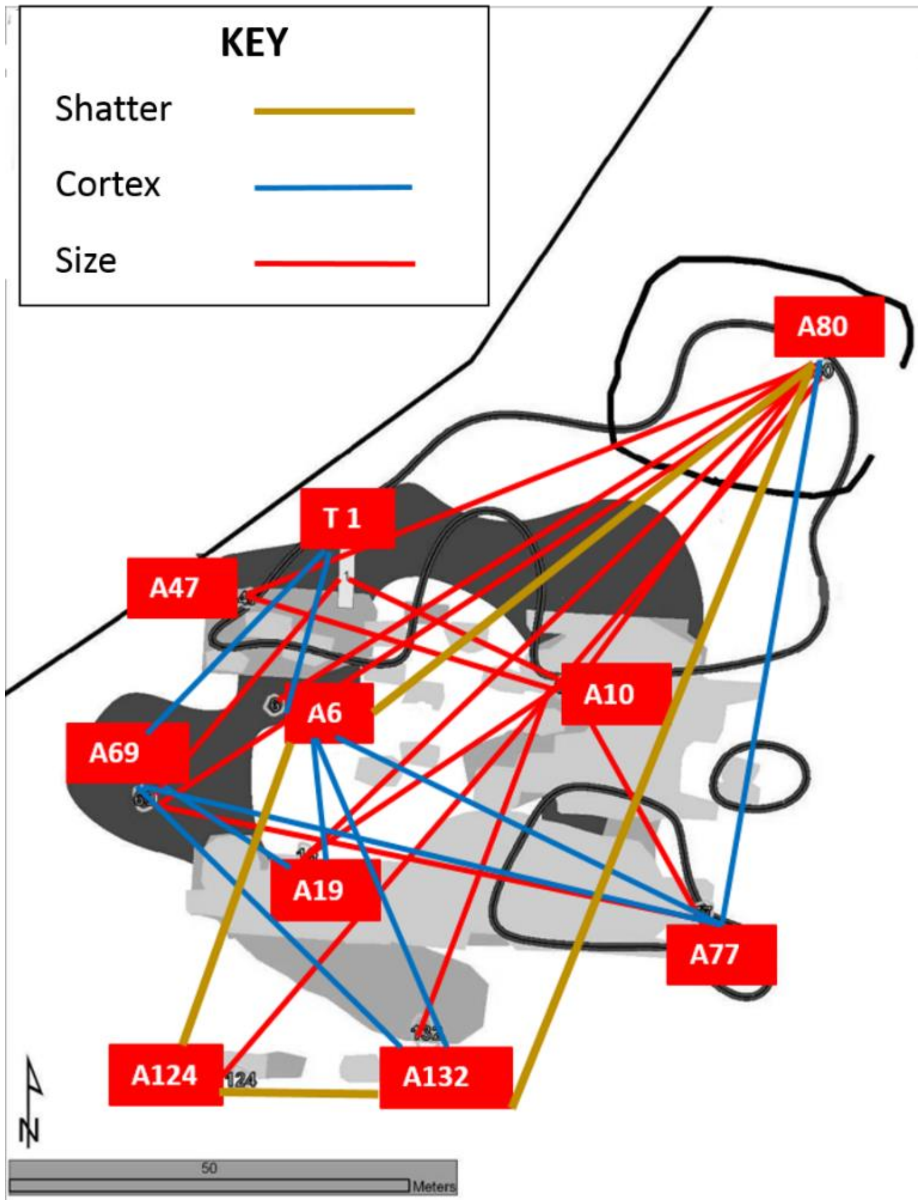


Figure 21: All differences